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ABSTRACT

This first volume of a two-volume set on prevention of cancer in the workplace is a teacher's guide designed to serve as a basis for lecture presentations and class discussions within the context of a formal course setting and structure. The course is organized into nine modules that can be taught using a lecture and discussion format in single instructional sessions of three hours each or in serial sessions. Each module contains objectives, lists of special terms, suggested teaching methods, special preparation needed, student assignments, information sheets, study questions, handouts, and references. The modules cover the following topics: an overview of cancer in the United States; major cancer theories; physiology, screening and treatment of cancer; carcinogens and cancer; testing carcinogens; carcinogens in the workplace; the impact of carcinogens on the environment; regulating carcinogens; and preventing cancer. A 23-page annotated bibliography, 13 pages of additional references, and suggestions for course-long assignments also are provided in the guide. (KC)

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PREVENTING CANCER IN THE WORKPLACE AND COMMUNITY

Volume I

Division of Behavioral Sciences and Health Education
School of Public Health, University of California, Los Angeles
and
Southern Occupational Health Center

Empire State College, State University of New York

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PREVENTING CANCER IN THE WORKPLACE AND COMMUNITY

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Volume I

Cancer, the Worker and the Workplace

A Teacher's Guide

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September 1983

PREFACE

Cancer and workplace carcinogen exposure is a subject of great concern both to workers and to the industrial community as an increasing number of new substances are introduced into work processes and the work environment. While scientists and policymakers argue the controversial issues surrounding cancer etiology and "safe" exposure levels, workers face the immediate threat of exposure to workplace carcinogens. Worker education, essential to the success of preventive measures, remains an ongoing challenge for unions, management and educational institutions.

Preventing Cancer in the Workplace and Community represents a collaborative effort to reduce the knowledge gap in the area of workers' education about cancer, its causes and its prevention. The two volumes in the series are the culmination of three years of collaborative work by the University of California, Los Angeles, School of Public Health, the Johns Hopkins University School of Hygiene and Public Health, and SUNY-Empire State College and its Center for Labor Studies. Each volume is intended for a different audience:

Volume I, Cancer, the Worker and the Workplace, is a teacher's guide designed to serve as a basis for lecture presentations and class discussions within the context of a formal course setting and structure. The prototype for this volume was originally developed and field-tested at the SUNY-Empire State College in Albany and its Center for Labor Studies in New York City.

Volume II, Cancer, the Worker and the Community, is a self-instructional manual designed for independent self-study by individual students who consult on a regular basis with an instructor. The instructor's role is to monitor student progress towards meeting objectives of the course. The prototype for this independent self-study was developed at the SUNY-Empire State College in Albany.

Prior to the development of both volumes, a survey of over 500 Center for Labor Studies students was conducted to assess workers' knowledge of cancer and carcinogens, and their attitudes and behavior regarding preventive action and health maintenance. Data from this survey were used to develop curricula designs that would reflect what workers need and want to know.

The following reviewers provided us with many useful comments from their areas of expertise: Drs. Anna Baetjer and Charles Billings, Department of Environmental Health Sciences; Dr. Morton Levin, Department of Epidemiology; Dr. Steven Schwartz, Department of Behavioral Sciences; and Mr. Michael Sheridan, doctoral candidate in the Division of Health Education, all from The Johns Hopkins University School of Hygiene and Public Health; Dr. Beatrice Kavasznay of the Bureau of Environmental Epidemiology and Occupational Health, New York Department of Health; Dr. Steven Hecher, Labor Education Center, University of Oregon and Dr. Frederick P. Li, Head, Clinical Study Section, Clinical Epidemiology Branch National Cancer Institute. We are indebted to them for their thoughtful critiques of the curricula's original draft. Marianne Brown, Andrea Hricko, Dr. Dean Baker, Division of Epidemiology and Dr. John Froines, Division of Environmental and Occupational Health Sciences at the UCLA School of Public Health provided valuable technical advice for the curricula's revisions. Dr. Jess F. Kraus and Dr. James Whittenberger assisted with support from the University of California Southern Occupational Health Center. We also wish to acknowledge the following for their assistance: Dr. Richard Dwyer, Ruth Mathews, Ellen Roznowski, Mari Scherne, the support staff of Empire State College, the students who provided valuable feedback and, at the University of California, Los Angeles, Phyllis Jacobson, curriculum consultant, Maria Cuevas, Ruth Gooley and Mary Hunter, Gila Weinstein, Judy Malunda and Jim Seale at the Word Processing Center.

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Introduction

Cancer has become not only a killer of epidemic proportions, but also a disease which has assumed the dimensions of a modern scourge. Cancer is widely regarded as the most dreaded of all disease - and no wonder, since one out of four Americans will develop cancer during his or her lifetime and one out of five will die from this disease. Members of our workforce are in even greater danger than the general public as exposure to a variety of chemicals, fumes, radioactive substances, and products containing asbestos dust greatly increase their risk of developing cancer. Yet we can substantially diminish cancer's toll by practicing what we already know about preventing the disease.

Some critics will say, "But you don't know what causes cancer, so how can you prevent it?" Although our knowledge of cancer causation is increasing rapidly each year, it is still limited and controversial. Most scientists do agree, however, that characteristics of our environment -- the air we breathe, the water we drink, the food we eat, as well as the work we do, are major contributors to our high cancer rate. Aspects of our lifestyle which similarly increase our risk of cancer include dietary, exercising and smoking habits. By taking appropriate action based on what is already known, these dangers may be greatly reduced.

The challenge for a worker education program is not only to credibly and effectively transmit information about cancer-prevention practices, but also to develop attitudes and behaviors necessary for the promotion of these practices in individual workers. Such knowledge and behaviors would help build a structure by which these workers may in turn positively influence others and in which industry and management may work productively with workers for the reduction of workplace hazards.

The present curriculum draws heavily on the body of adult educational theory emphasizing participatory learning. As Rogers and Shoemaker (1965) observe, one of the most obvious and fundamental principles of human communication is that the transfer of ideas most frequently occurs between source and receiver who are alike in attributes such as beliefs, values, education, social status and the like. Applied to occupational health education, then, the most effective communicator of ideas to workers are not the experts and professionals most likely to have technical knowledge, but rather other workers. Considering this, we have designed a program in which we attempt to teach workers the principles of occupational health and preventive health actions in a manner which will enable them to, in turn, teach what they learn to other workers.

Our field test of this curriculum took place at two centers of Empire State College of the SUNY system: The Center for Labor Studies in New York City and the Albany Center. The Albany Center is similar to the University without walls model whereby instruction is through individualized study, while the Center for Labor Studies has the more traditional regularly scheduled classroom sessions. The population at the Center for Labor Studies is unique in that it is almost entirely composed of blue collar workers who have combined full time jobs during the day with an evening program of study. We administered a baseline questionnaire to 500 members of this population to assess their educational needs, priorities, attitudes, knowledge and practices regarding work exposure to carcinogens. About half of this student population was below the age of 23, 25% was between 24 and 35 and another 25% was over 35. Most students were white (73%), with Black and Hispanic students comprising 17% and 9% of the population respectively. Eighty-nine percent of the students belonged to organized labor, predominantly the International Brotherhood of Electrical Workers (IBEW) and the Teamsters.

We also asked these students to prioritize areas of study that should be included in the curriculum. Those considered most important related to recognition of hazards, workers' rights (including worker's compensation and the function of OSHA) and information regarding basic characteristics of cancer in the body. The second most important group of items related to personal protective devices and engineering controls, useful techniques for outreach to other workers and ways to make health and safety committees more effective. The lowest rated items related to direct medical care.

The results of the baseline survey were useful in the design of the curriculum. They enabled us to better assess student-workers':

1. current knowledge of cancer and carcinogenic work substances;
2. attitudes about the priority that should be placed on health and safety and the perceived efficacy of preventive health actions;
3. experiences with exposure to hazardous substances or conditions;
4. specific skills and strategies previously used in response to hazardous situations; and
5. ability to organize and talk with other workers about health and safety issues.

These findings were reflected in the primary foci of our course:

a. To provide students with basic information and to promote skills, attitudes, and behavior which would contribute to a reduction in work hazards; and
b. To facilitate the diffusion of learning to the wider population of students' co-workers.

The curriculum was revised as a result of the field trial described above. The present course thus reflects the belief that worker education together with grassroots organizing and communication are the key elements in the prevention of occupational and environmental cancer. Course learning goals include the transfer of technical information about cancer from instructors to worker-students, and the development of students' ability to transfer this information in turn to co-workers, neighbors and family members. To meet these goals, the modules in the curriculum include both technical information and practical exercises to allow students to apply relevant information to their own work environment.

Note to Instructors

Some students may be reluctant to discuss hazardous situations and the implications of exposure to carcinogens with co-workers, family members and neighbors because of the very personal threat of developing cancer. However, in our experience, students who have discussed cancer and carcinogens with friends as part of the course requirement report this to be the most fulfilling part of the course.

The emotional impact of cancer can be overwhelming. It is possible that, during the course, someone's friend or relative may face the disease. In these instances, the limitations of public educational information on cancer are overwhelmingly obvious. You, as instructor, may be looked to for technical information and for emotional support. Although this can be troubling, it underscores the immediacy of the course content and the need for increased information on the subject. In these situations, familiarity with local cancer treatment facilities and counseling services on cancer rehabilitation or death and dying will be invaluable.

It is essential to remember that much of the information presented here is controversial. In many instances, there are no right or wrong answers. The goals of the course are to help students appreciate the complexity of the issues, to develop their ability to ask critical questions and to facilitate the development of practical programs which can support an overall cancer prevention effort.

Structure of Curriculum

The curriculum is presented in a series of nine individual modules. The modules can be taught using a lecture and discussion format in single instructional sessions of three hours each or in serial sessions, ideally separated by a week to provide sufficient time for students to complete assigned projects. Each module is designed as a cohesive unit. However, some of the modules contain more material than can be presented in a single class session if sufficient time is allowed for the class discussions, an essential component of the series, designed to develop students' analytical and communication skills. Instructors should use their judgement in determining how to divide the material contained in a module, when to divide into small groups for discussions and where to insert audio-visual or guest presentations. The materials in this guide are intended for use as a base from which the instructor can prepare his/her class lectures. The instructor can adapt the materials, class exercises and study questions to different audiences. For each module, a list of references and study questions are included in addition to on-going assigned projects. Study questions, reading material and assigned projects should be selected, based on the students' backgrounds, needs and time limitations. While the curriculum was initially prepared for classroom instruction in a labor college, the content of the curriculum and the method of instruction are adaptable to other educational settings, including training workshops and discussion groups.

The curriculum is designed so that each module will contribute to the achievement of two major objectives:

1. To provide technical information through class lectures and readings about occupational and environmental cancer.

2. To facilitate the personal application of knowledge and the development of skills and strategies for use in the workplace and community.

Each module outlines the specific learning goals and special terms to be used. Teachers should refer to these at the close of each module to be sure that the goals have been met and that the terms have been explained. Since the course objectives include both teaching technical information and facilitating students' ability to apply and disseminate this information in the workplace, the learning process places a special responsibility on the learner. We do not expect students to become occupational health or cancer experts; however, we do expect them to be able to intelligently discuss cancer and hazardous work situations with members of their families and their co-workers. They will also learn to identify hazardous substances or situations and to take appropriate steps to reduce everyone's risk of contracting cancer.

Every effort has been made to make the content current. However, because of the changing state of knowledge, it is essential that an ongoing review of materials be carried out by the individual instructor. Collecting related newspaper articles as described below will facilitate this process.

Course Assignments

In addition to the study questions and exercises which are provided in each module, three projects may be carried out through the entire course:

1. **Media Watch**

   One of the primary course goals is for the students to actively utilize the material presented after the course ends. Therefore, it is essential that students increase their level of awareness of current events related to the course. To accomplish this, students should be instructed to clip cancer-related articles from newspapers and other sources which are course-related. These articles should be kept in a scrapbook for the duration of the course. This will not only help students realize the relevance of the class, but will also help keep the class current. To assure student participation, two students per week should be responsible for checking newspapers and for reviewing the television schedule to alert the class to local media coverage. Those students should be prepared to present any findings that relate to the material contained in the previous module.

2. **Taped Interviews**

   Throughout the course, each student should be responsible for conducting tape recorded interviews with co-workers, friends or family members about the material covered in class. There are two opportunities for conducting the taped interviews during the course. During the first half of the course students will informally interview at least three people about carcinogenic hazards they are likely to encounter. Near the close of the course students will more formally present material learned in class to a group of 5-6 co-workers, friends or relatives. This material will be the basis of discussion between the group members. The purpose of the interviews is to provide the student with the experience of discussing class material with non-class members. For each interview, the student should develop a series of discussion questions and an outline of references and factual information. The student should provide the interviewee(s) with concrete information and a fact sheet during the interview. Be sure to spend some classroom time discussing students' experiences and giving them feedback on their efforts. This exercise is a critical one and will lay the foundation for future outreach and educational activities by students. Some classroom time may be set aside to listen to the best of these taped interviews or presentations during each half of the course.

3. Workplace/Community Carcinogen Investigation

Various ways of investigating workplace carcinogens (and to a lesser degree, community carcinogens) are described throughout the modules. (See Curriculum Overview below and the Assignments section at the start of each Module.) Students should apply their classsroom knowledge to their own situation by beginning an on-going investigation of the existence of carcinogens in their workplace or neighborhood and the steps that groups have already taken to control carcinogen exposure. They should develop possible solutions to existing problems.

Several assignments ask the student to request information about workplace substances from their employer. The instructor should, however, encourage students not to ask for information from anyone they fear may take retaliatory action. Those students should discuss the problems they face and suggest alternative ways of investigating the problem.

This project is most appropriate when the class sessions are scheduled a week apart since some of the assigned activities may take time (e.g. requesting information and waiting for a response). Students can then do their investigation in a step-by-step manner, discussing their efforts with the instructor and with other students at each class session. A final project presentation (see Module 8 Assignments) can be used for evaluation purposes and for facilitating the process of students' communicating and learning from other workers' personal experiences.

The Taped Interview and Carcinogen Investigation assignments will vary from student to student depending on their personal experiences. Since the course is designed primarily for workers, most students will probably be employed. However, some students may not be working - they may be full time students or currently unemployed. Those students should investigate community carcinogen exposure rather than workplace exposures.

Reading Assignments

The two textbooks used for the course are:

Chemicals, Work and Cancer by LeServe, Vose, Wigley and Bennett, Thomas Nelson & Sons, Ltd., England, 1980. This text was chosen because it is a useful and concise summary of scientific information on chemical carcinogenicity.

The Politics of Cancer by Samuel Epstein.

- Hardback - Sierra Club Books, San Francisco, 1978. (Page numbers in the text refer to the hardback edition.)
- Paperback - Anchor Press, New York, 1979.

This text was chosen because it is understandable, controversial, and stimulates critical thinking.

These two texts should be supplemented with additional readings. A list of suggested readings is included with each module. Also, a bibliography has been included at the end for the instructor's use. Part A is annotated. Part B includes a more exhaustive but unannotated list for the instructor who is interested in further reading in a specific area. The bibliography includes some useful references on radiation, a topic not adequately discussed in the modules or in either of the texts, both of which focus on chemical carcinogens. Radiation is also an important pervasive workplace and community carcinogen. The modules include brief sections on radiation but do not attempt a detailed coverage of the complicated field of radiation physics, carcinogenesis, regulation and control.

Several resources included in the bibliography or in the modules are extremely useful and should be requested well in advance for use by the instructor or for distribution to students.

1. Cancer Rates and Risks, published by DHEW, Publication # (NIH) 79-691.

2. The American Cancer Society's Cancer Facts and Figures (latest year). Available from local American Cancer Society offices.

3. The Case of the Workplace Killers: A Manual for Cancer Detectives on the Job. International Union, United Automobile, Aerospace and Agricultural Workers of America. 8000 E Jefferson, Detroit MI, 48214.

4. For distribution in Module 6:
   Factsheet entitled "Respirator Protection," available from the Western Institute for Occupational/Environmental Services, Inc., 2520 Milvia, Berkeley, CA, 94704, (415) 845-6476.

4. For distribution in Module 6:
   Factsheet entitled "Design of Local Exhaust Ventilation" prepared by the International Union of the United Automobile, Aerospace and Agricultural Workers of America. 8000 E. Jefferson, Detroit, MI, 48214.

For instructor's use:

1. The following A-V materials for optional use in Module 3 are available on free loan from local American Cancer Society (ACS) offices:

   - ACS. "The Embattled Cell." 1980 (film)
   - ACS. "From One Cell." 1978 (film)
   - ACS. The Nature of Cancer. 1975 (Teaching kit for senior high school students)

2. For optional use in Module 7:

Davis, David and Josh Hanig. Song of the Canary. 1979 (film) Distributed by New Day Films, P.O. Box 315, Franklin Lakes, NJ, 07417, (201) 891-8240.

Switzgable, Meg. In Our Water. 1981. (film) Distributed by New Day Films, P.O. Box 315, Franklin Lakes, NJ, 07417, (201) 891-8240.

In addition to the above, many useful student handout brochures are available free or for minimal charge from state or local agencies; e.g. brochures about cancer from the American Cancer Society (ACS), fact sheets on workplace carcinogen control from unions or COSH groups (See Module 9, page IX-23 for a description of COSH groups), brochures on workers' rights from OSHA offices. Each of these organizations should be contacted in advance so the instructor can make use of local resources.

Evaluation

At the Empire State College-Center for Labor Studies, students were evaluated by two examinations, their taped interviews and a final paper. Also, see the Module 8 Assignment section for suggestions for a final project based on the students' on-going workplace/community carcinogen investigation. A similar project was used in a course on Occupational Safety and Health sponsored by the Los Angeles Committee on Occupational Safety and Health (LACOSH) and the Los Angeles Trade Technical College for workers in 1983. The suggested ongoing projects described in #3 above (Course Assignments) and the assigned final project are adapted from that course. An ideal time frame for the class would allow a few sessions for students to present their final projects and for the class to listen to selected taped interviews after all the material in the modules has been completed. Evaluation methods should be chosen based on the assignments that are selected and on the orientation of the class.

Curriculum Overview

Goals for both technical learning and individual skill development are summarized for each module. They are outlined below.

CURRICULUM OVERVIEW

MODULE	TECHNICAL INFORMATION	STUDENT SKILL DEVELOPMENT	STUDENT ACTIVITIES
I. An Overview of Cancer in the United States	Cancer as a major problem in the U.S. Scientific/statistical terminology defined	Demystify statistics Interpret scientific data	Media Watch Complete Workplace Health Hazard Survey forms Contact local cancer resource agencies for information about their activities
II. A Review of the Major "Cancer Theories"	The development of scientific theory Theories of cancer causation	Critically evaluate scientific information Analyze the legitimacy of cancer theories	Media Watch Complete workplace survey forms Prepare brief presentation about local cancer resources
III. Physiology, Screening and Treatment of Cancer	Principles of cancer physiology, diagnosis and treatment Different types of cancer prevention programs	Understand and explain medical terminology and information about cancer	Media Watch Bring in labels of workplace/home substances to increase awareness of chemicals in the environment
IV. Carcinogens and Cancer	Principles of carcinogenesis Common occupational carcinogens Interactions between carcinogens and the exposed individual	Relate classroom learning to personal experiences with workplace and community carcinogens Facilitate students' ability to work in small group discussion settings	Media Watch Conduct the first taped interviews
V. Testing Carcinogens	Epidemiologic, animal and short-term carcinogen testing	Develop and support beliefs about the criteria that should be used to predict carcinogenicity	Media Watch Prepare outline and handout material for the 2nd group taped interview

CURRICULUM OVERVIEW

MODULE	TECHNICAL INFORMATION	STUDENT SKILL DEVELOPMENT	STUDENT ACTIVITIES
VI. Carcinogens in the Workplace: Hazard Investigation and Control	Pragmatic solutions to investigating and controlling carcinogens in the workplace	Use information provided to investigate the existence of carcinogens	Media Watch Request information about workplace hazards, specifically that described in the module Investigate past union activities around occupational health and safety Investigate the existence of current workplace control measures
VII. Carcinogens and the Community	Priniciples of ecology	Understand and explain how carcinogens at the workplace may affect the surrounding community	Media Watch Conduct group taped interview Continue with ongoing workplace/community carcinogen investigation
VIII. Regulating Carcinogens	Overview of carcinogen regulatory efforts at the federal and state level Review of economic, social and political factors affecting the success and failure of regulatory efforts	Formulate ideas for community and worker organization's input into the regulatory process	Media Watch Develop outline for final project based on the carcinogen investigation project and the taped interviews: statement of major carcinogen hazards and proposal for actions to control those hazards
IX. Preventing Cancer	Case-Study: Asbestos, Smoking and Cancer Approaches to primary prevention: individual and collective action	Discuss the case-study of asbestos as it relates to the concepts presented in Modules 1-8 Develop good problem-solving skills with respect to asbestos and to personal work hazards	Present final project proposal for controlling workplace or community carcinogens

Table of Contents

Page

Preface i

Introduction iii

Module 1: An Overview of Cancer in the United States I-1
- Lesson Objectives I-1
- Special Terms I-1
- Teaching Method I-1
- Special Preparation I-2
- Assignments I-4

- I. Overview I-5
- II. Cancer Mythology I-5
- III. Cancer in the 20th Century I-6
- IV. Cancer Statistics I-9
  - A. Key Concepts I-9
  - B. Using Statistics I-13
- V. Trends in Cancer Incidence and Mortality Rates I-15
  - Study Questions I-17
  - References I-18

Mo[illegible]le 2: A Review of the Major "Cancer Theories" II-1
- Lesson Objectives II-1
- Special Terms II-1
- Teaching Method II-1

Page

Special Preparation II-2
Review Materials II-2
Assignments II-2

I. Limitations of Science & Scientific Theory II-3
   A. Science: A General Perspective II-3
   B. Cancer Theories II-6
II. Review of the Theories II-8
   A. The Viral Theory II-8
   B. The Genetic Theory II-9
   C. The Environmental Theory II-9
Study Questions II-15
References II-16

Module 3: Physiology, Screening and Treatment of Cancer III-1
Lesson Objectives III-1
Special Terms III-1
Teaching Method III-1
Special Preparation III-2
Review Material III-2
Assignments III-2

I. Introduction III-4
II. Cancer Physiology III-5

Page

- A. Cellular Replication III-5
- B. Tumors III-7

III. Diagnosis III-8

IV. Cancer Treatment III-13

- A. Traditional Medical Treatments III-13
- B. Non-Traditional Medical Treatments III-14

Study Questions III-19

References III-21

Module 4: Carcinogens and Cancer IV-1

Lesson Objectives IV-1

Special Terms IV-1

Teaching Method IV-1

Review Material IV-1

Assignments IV-1

I. Introduction IV-1

II. Which Substances Cause Cancer IV-3

- A. Chemicals IV-4
- B. Radiation IV-5

III. Theories of Carcinogenicity IV-7

IV. Individual Susceptibility IV-20

Study Questions IV-26

References IV-27

Page

Module 5: Testing Carcinogens V-1
Lesson Objectives V-1
Special Terms V-1
Teaching Method V-1
Special Preparation V-1
Review Materials V-2
Assignments V-2

I. Introduction V-3
II. Epidemiologic Testing V-3
A. When Should Epidemiologic Studies be Considered V-6
B. How Are Epidemiologic Studies Conducted V-7
III. Animal Testing V-15
A. An Overview of Animal Tests V-15
B. Factors Affecting Animal Studies V-19
IV. Short Term Carcinogen Tests V-19
Study Questions V-22
References V-23

Module 6: Carcinogens in the Workplace: Hazard Investigation and Control VI-1
Lesson Objectives VI-1
Special Terms VI-1
Teaching Method VI-1

Page

Special Preparation VI-2
Review Material VI-2
Assignments VI-2

I. Introduction VI-4
II. The Role of Management and Labor VI-4
  A. Management Responsibility VI-4
  B. Worker Responsibility VI-5
III. Setting Up a Carcinogen Control Program in the Workplace VI-8
  A. Health & Safety Committees VI-8
  B. Investigating Carcinogen Exposure VI-9
  C. Controlling Carcinogens VI-13
Study Questions VI-20
References VI-21

Module 7: The Impact of Carcinogens on the Environment VII-1
Lesson Objectives VII-1
Special Terms VII-1
Teaching Method VII-1
Special Preparation VII-1
Review Material VII-2
Assignments VII-2

Page

I. Introduction VII-3

II. Ecosystems & How They Work VII-3

  A. Overview VII-3

  B. Natural Cycles VII-4

  C. Food Chain Contamination VII-9

  D. Natural Clean-Up VII-10

III. Environmental Contamination & Community Health VII-13

  A. Paths of Exposure VII-13

  B. Effects on the Family's Health VII-19

Study Questions VII-21

References VII-22

Module 8: Regulating Carcinogens VIII-1

Objectives VIII-1

Special Terms VIII-1

Teaching Method VIII-1

Special Preparation VIII-2

Review Material VIII-2

Assignments VIII-3

I. Regulatory Process VIII-5

  A. Overview VIII-5

  B. Standard-Setting Process: The Example of OSHA VIII-6

  C. Public Input VIII-7

Page

II. Federal Regulatory Agencies VIII-8
  A. The Food and Drug Administration (FDA) VIII-8
  B. The Consumer Product Safety Commission (CPSC) VIII-9
  C. Environmental Protection Agency (EPA) VIII-10
  D. Occupational Safety and Health Administration (OSHA) VIII-13
III. The Standard-Setting Process: A Generic Carcinogen Policy VIII-16
IV. Right-to-Know Law VIII-17
V. Risk Assessment VIII-21
  A. Cost-Benefit Analysis VIII-22
  B. How to Look at Cost-Benefit Analysis VIII-23
  C. How to Measure Cost and Benefit VIII-23
  D. Cost-Benefit Analysis in the Regulatory Process: the Vinyl Chloride and Cotton Dust Standards VIII-24
Study Questions VIII-26
References VIII-27

Module 9: Preventing Cancer IX-1
Lesson Objectives IX-1
Special Terms IX-1
Teaching Method IX-1
Special Preparation IX-2

Page

Assignments IX-2
Review Material IX-2

I. Asbestos - A Case Study IX-3
    A. Overview of the Problem: Extent of Asbestos Exposure and Effects IX-3
    B. Scientific Theories and Asbestos IX-4
    C. Physiology, Screening and Treatment IX-6
    D. Asbestos and Cancer IX-7
    E. Testing Asbestos IX-9
    F. Asbestos in the Workplace - Investigation and Control IX-10
    G. Asbestos in the Environment IX-12
    H. Regulating Asbestos IX-13
II. Smoking and Cancer IX-16
    A. Lung Cancer - An Overview IX-16
    B. Smoking - An Overview IX-17
    C. Preventing Cancer - Smoking Cessation IX-18
III. Individual and Collective Action IX-19
    Study Questions IX-25
    References IX-27

Bibliography

A. Annotated References X-1
B. Additional References X-24

MODULE 1: AN OVERVIEW OF CANCER IN THE UNITED STATES

Lesson Objectives:

By the end of this session, students will be able to:

1. Explain why cancer is considered a major public health problem in the United States.
2. Discuss how reported cancer incidence and mortality rates have changed during the 20th century.
3. Explain how changes in society, in the medical community, and in industry may have contributed to those changes.
4. Define basic cancer-related statistical terms.
5. Identify the strengths and weaknesses of utilizing existing statistics for setting priorities and for allocating resources for cancer research and prevention.
6. Identify the major sites of cancer by sex and race in the United States.

Special Terms:

Age Adjustment
Crude Rate
Incidence
Incidence Rate
Mortality
Mortality Rate
Prevalence
Rate
Relative Risk

Teaching Method:

Lecture
Class Discussion

Special Preparation

1. Bring butcher paper or posterboard on which to list the class's responses to the questions posed on page I-5 and I-6. File the responses for future use as a feedback mechanism. The same questions can be posed in Module 9 and responses compared.

2. Prepare examples of rates for students to work with in the class exercise described on page I-13.

3. Contact the local or state health department for information about the kind of cancer data collection system used in the state (See Class Discussion, page I-14).

4. Contact the local American Cancer Society (ACS) office (or local universities, state or local health departments, etc.) for a list of local cancer prevention and treatment agencies that service the public. (See Assignment #5 below.)

5. Prepare handout materials:
   - New York Times articles assigned for Study Question 7 (See References #3 and #4). If there is a more current controversial issue for which news clippings are available and similar questions can be raised, use those articles instead.
   - List of local cancer resource agencies for students to contact (See Assignment #5 below).
   - Health Hazard Survey Form (see assignement #4 below).
   - Current ACS Cancer Facts and Figures available from the local ACS office.

6. Bring in a scrapbook with a few newspaper clippings on cancer and carcinogens as examples of appropriate articles for the Media Watch project.

Assignments:

For all students:

1. Assign selected reading material from the texts and selected study questions from those listed at the end of the module.

2. Describe the Media Watch project as discussed on page viii and assign two students to:
   - clip relevant articles from newspapers and magazines
   - jot down notes from TV and radio news coverage
   - review the TV schedule for special programs on cancer or carcinogens

3. Describe the Taped Interview assignments as described on page viii so students can begin considering whom they might interview.

The workplace exposure assignment described below may not be relevant to all students in the class. Those students who are currently employed can complete that assignment based on experiences at their own workplace; others who are full-time students or who are currently unemployed can complete the alternative assignment. Students will have until the third session to gather the necessary information but should be encouraged to begin immediately so they can discuss any problems they encounter at the next class session.

Workplace assignment:

4. Distribute a Health Hazard Survey form (See Appendix A or use another appropriate form if available through a local union or COSH group). Instruct students to complete as much of the information as they can for their workplace. However, students who work with antagonistic supervisors should not feel obligated to request information if they feel uncomfortable doing so. These results will be used in future sessions and will provide an overview of the most common hazards faced by students in the class.

Alternative assignment:

5. Assign several students to contact local cancer resource agencies for information about the kind of services they provide - educational, referral, testing, diagnosis, treatment, etc. If there are no currently unemployed students to complete this assignment, you, as instructor, should be prepared to provide a brief overview of local cancer resource agencies at the third session or contact a local American Cancer Society (ACS) representative to do so.

MODULE 1: AN OVERVIEW OF CANCER IN THE UNITED STATES

I. Overview

Many people think of cancer as one disease: "No matter where the disease appears, cancer is cancer." In fact, "cancer" refers to a family of diseases, each with different rates and different risks. We must constantly keep this in mind if we hope to understand the complex information presented here. This first module reviews what people "feel" about cancer and what scientists "know" about who is affected by this disease. Students will begin to familiarize themselves with cancer data and learn how to interpret certain key statistical terms frequently used in cancer research.

II. Cancer Mythology

Studying a complicated subject like cancer involves becoming familiar with statistics and with technical information. Putting this information into a context from which a preventive strategy can be developed requires examining commonly held beliefs about cancer and exploring the class's personal knowledge of cancer.

During the students' lifetime, cancer will affect at least one member in 70% of American families. Very few of us will escape either directly or indirectly confronting this disease. The general population's knowledge about cancer, its treatment and its prevention significantly affects society's ability to cope with the disease. Examining the class's own knowledge of cancer may provide some insight into commonly held beliefs about cancer.

Class Discussion:

Use the following questions to assess the class's knowledge of cancer.

1. What is cancer?
2. Do bruises cause cancer?

3. What is the most common body site of cancer for men and for women in the U.S.?
4. Is cancer hereditary?
5. Does everything cause cancer?
6. Do you think that cancer can be prevented? How?
7. Is cancer on the rise or on the decline in the U.S.?

The answers to the above questions are included in this and the following modules. For the moment, write down and retain the class responses for comparison and feedback in Module 9. In addition, several surveys of public knowledge and attitudes about cancer are available for comparison purposes. (See Reference #6.)

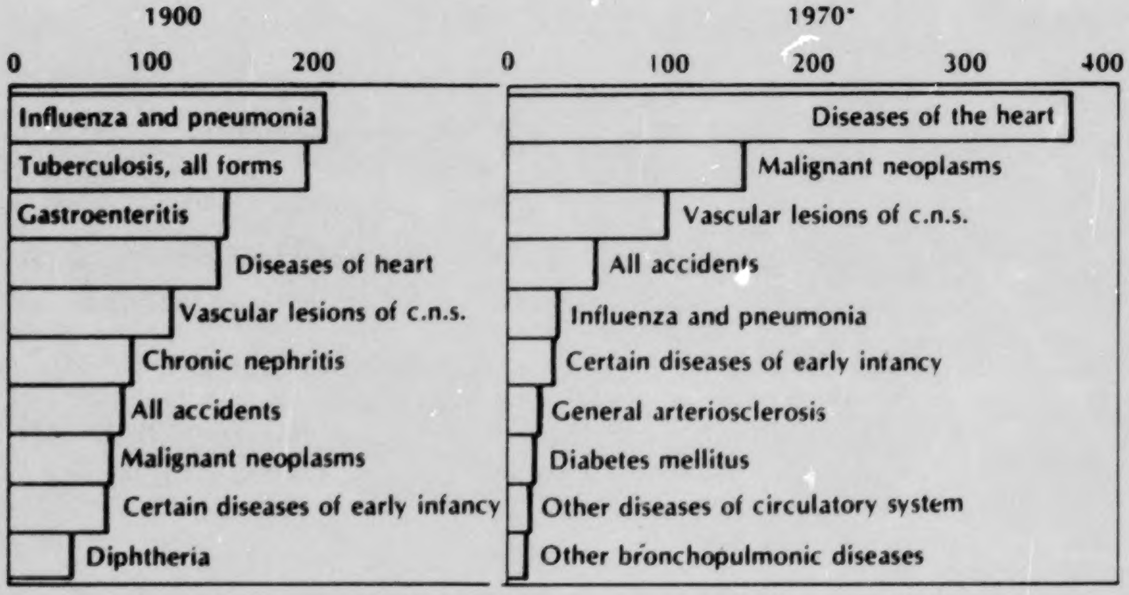
III. Cancer in the 20th Century

Cancer is a disease which has been known for centuries. However, as a result of the precipitous rise in the number of cancer deaths during the 20th century, many experts consider cancer a disease of industrialized society. Comparison between the major causes of death in 1900 and today provides insight into the association between cancer and our modern day lifestyle.

In 1900, pneumonia and influenza were the leading causes of death in the United States. Cancer was number eight, accounting for less than 4% of all deaths. Today, cancer is the second leading cause of death, accounting for over 21% of all United States deaths. One in four people will get cancer sometime; one in five will die from this disease (American Cancer Society, 1982).

Table 1 compares death rates for the ten leading causes of death in the U.S. in 1900 and 1970. Certain changes in technology, science, medicine,

Table 1



Death rates for the ten leading causes of death per 100,000 population, United States, 1900 and 1970. (From Linder, F. E., and Grove, R. D.: Vital Statistics Rates in the United States, 1900–1940. U.S. Govt. Printing Office, Washington, D.C., 1943 [data for 1900]; National Center for Health Statistics: Annual Summary for the United States, 1970. Monthly Vital Statistics Report, Vol. 19. U.S. Dept. of Health, Education, and Welfare, USPHS, U.S. Govt. Printing Office, Washington, D.C., 1971 [data for 1970].)

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*Based on 10 per cent sample of death certificates.

In the table, "Malignant Neoplasms" refers to cancer, "C.N.S." refers to the central nervous system and nephritis refers to inflammation of the kidney. The table was taken from Mausner and Bahn (1974).

public health and other areas of society may have contributed to these dramatic shifts by decreasing the occurrence or severity of some diseases and by increasing that of others. Some of these changes include:

- Improvements in drug therapy (e.g. the development of penicillin or vaccines) decreased the severity of influenza, pneumonia, tuberculosis, etc.

- Public health improvements (e.g. sewage treatment and drinking water purification) eliminated a large source of gastrointestinal communicable organisms.

- Industrial changes (e.g. the growing use of chemicals and radiation) have exposed more workers to potential cancer-causing substances.

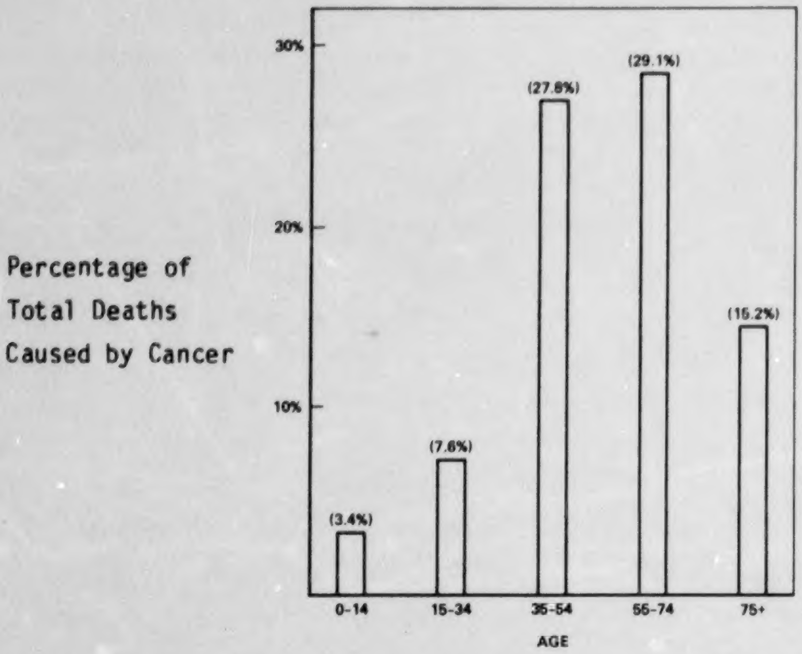
- Medical advances (e.g. x-rays, chemotherapy, hospital care) have improved the prognosis for victims of cancer and of heart diseases.

- Changes in record-keeping procedures (e.g. formation of tumor registries and state health department data collection requirements) have improved morbidity and mortality figures on individuals with chronic disease. Consistent record-keeping is essential to a clear picture of cancer mortality; if record-keeping is sporadic or incomplete, a change in record-keeping practices may appear to be a change in death or disease.

- An aging population (the average life expectancy of white males in 1900 was 48.2 and in 1979 was 70.2). This does not imply that the increase in cancer in this century is an expected result of the natural aging of the population. It does mean that, since acute diseases (flu and pneumonia, gastrointestinal diseases, etc.) have been controlled by public health measures and by medical advances, children survive the early years of life (a susceptible period when mortality from acute diseases used to be especially high). This increases the average age of death and increases the chances of dying from chronic diseases for people of all ages.

Figure I illustrates the fact that cancer affects everyone by showing the percentage of deaths from cancer for all age groups. Both young children and adults are affected by cancer. Statistical analyses show that between 9.5% and 27% of the rise in the cancer death rate is due to the increased risk of cancer among younger age groups (Epstein, p. 17).

Figure 1: Percent of Total Deaths in 1979 Caused by Cancer According to Age



Source: National Center for Health Statistics, 1982

IV. Cancer Statistics

A. Key Concepts

Learning scientific terms is an essential part of the process of becoming familiar with scientific information. The following statistical concepts are considered the basic tools for understanding and interpreting commonly used cancer data (Mausner, 1974).

Incidence - the number of NEW cases of an event occurring in a population, usually during a year. For instance, the 1976 incidence of cancer (all sites) was estimated to be 765,000; i.e. 765,000 new cases of cancer appeared during that year.

Prevalence - the number of ALL cases of a disease at a given time; this includes both the number of new cases of disease within a defined time period and the number of previously existing cases of the same disease.

Mortality - the number of deaths occurring in a population, usually during a year. The number of deaths in 1976 attributed to cancer was 377,312.

Rate - A measure of the number of events within a certain time period for a defined population. Rate measurements give an idea of the proportion of the population that is affected by death or disease. It is not adequate to know simply that the mortality from cancer in a country in one year is 100. We must also know how large the population is. For example, we would be concerned if we discovered that in County A, which had a population of 1,000 people, 100 people had died of cancer in the past year. But we would be even more concerned if we knew that the same number of people (100) in a population half that size in County B had died in the past year. The mortality rate in County B would be much higher even though the actual number of cases is the same.

County A $\frac{100 \text{ deaths}}{1{,}000 \text{ people}} = \frac{1}{10}$ (10%) of the population

County B $\frac{100 \text{ deaths}}{500 \text{ people}} = \frac{1}{5}$ (20%) of the population

Rates allow us to compare different sized populations. If we looked only at the actual number of cases in the above examples, we would say that both counties have an equally serious problem with cancer. But the rates indicate a greater problem in County B because they tell us that a greater proportion of the population is affected (20% in County B vs 10% in County A).

A common method of comparing rates between populations is to ask what proportion of people die from cancer out of a specified number of people in those populations. The figures above indicate that 10% or 10 out of 100 people in County A and 20% or 20 out of 100 people in County B died of cancer. Rates of death or disease are often given for 10,000 or 100,000 people in the population. This gives a common denominator which facilitates comparisons between populations of different sizes.

Incidence Rate - the number of new cases per year per set number of the population (usually per 100,000). For example, the National Cancer Institute's estimate for the incidence rate of cancer in the U.S. for the period of 1973 - 1977 was 332/100,000 (332 new cases of cancer per 100,000 U.S. inhabitants).

Prevalence Rate - the number of new cases of disease per year and the number of previously existing cases of disease per set number of the population.

Mortality Rate - the number of deaths per year per set number of the population (usually per 100,000).

Rates of illness or death can be given as an average for the entire population (crude rate) or for specific groups within the population (specific rates).

Crude Rate - any rate (incidence, prevalence, mortality rate, etc.) which is based on the morbidity or mortality experience of everyone in the population. Crude rates make it easy to compare statistics in different populations because there is only one average statistic for the total population. We can make a simple comparison of the U.S. incidence rate of cancer given above (332 cases per 100,000 people per year) with the incidence rate of cancer in other counties. However, one statistic does not give detailed information which might enable us to explain why there are differences between countries. If one country has a higher incidence of cancer, we do not know whether everyone in the country is equally affected or whether specific groups of people have especially severe problems, thus raising the rate for the entire country.

Specific Rates - the number of cases of death or disease per year per a set number of people in a specific group. Specific rates are most often given by age, sex or race. For example, the age-specific death rate per 100,000 people for the age group of 25 - 34 years would be:

$$\frac{\text{the number of deaths among people aged 25 - 34 in a year}}{\text{the average population aged 25 - 34 in the same year}} \times 100{,}000$$

Sex- or race-specific rates are calculated in a similar way for the specific category with which we are concerned - male or female; black, white, Hispanic, etc.

Age-Adjustment - Since people of different ages are affected differently by death and disease, the age distribution of populations must be similar in order to make valid comparisons. Since this is not usually the case, we can compare different aged populations in one of two ways. We can compare age-specific rates for each age group, e.g., compare the incidence of cancer among people aged 20-25 in several populations. Or we can "age-adjust" the groups and calculate a rate for each as though their age distributions were the same. Age-adjusting can make comparisons simpler than comparing the larger number of age-specific rates, especially if a large number of populations are being compared.

Relative Risk or Risk Ratio - the increased risk of developing disease among an exposed group relative to a non-exposed group. For instance, Epstein provides data on a group of workers exposed to asbestos for some 30 years as part of their job with the Union Asbestos and Rubber Company in Paterson, New Jersey. Among this group, the workers' death rate was 50% greater than that of the population of average American males. Lung cancer greatly exceeded the expected rate for that group. The relative risk (or risk ratio) of death from lung cancer for these workers was seven; 89 deaths observed/11.68 deaths expected = 7 (Epstein, p. 85).

Class Exercise

The above rates should be illustrated in class with concrete examples. Students should practice calculations themselves to demystify and develop a working knowledge of simple statistical measures.

Statistics should be used and evaluated with caution because they can be abused either knowingly or unknowingly. Several errors are particularly common:

1. Comparing incidence rates with mortality rates in different populations or in the same population at different times.
2. Comparing numbers with rates.
3. Comparing morbidity and mortality statistics between populations without adjusting for age differences.
4. Believing anything that uses statistics - statistics can be made to lie or to exaggerate.

B. Using Statistics

Cancer statistics have a wide variety of uses which can affect individuals and society as a whole. Statistics are used to determine disease trends, to set priorities for governmental and private research, to allocate limited health care resources, and to develop cancer prevention programs for the individual and for the community.

The primary sources of cancer data in the U.S. are the National Cancer Institute (NCI), NCI's Surveillance, Epidemiology and End Results Program (SEER), which gathers data from eleven population-based registries, state tumor registries, and state and local health department statistics. The quality of cancer statistics varies from state to state.

Class Discussion:

> Discuss the system of data collection for the state where the class is being held. Ask the class to suggest potential sources of bias (incompleteness or inaccuracies) in the data.

Because of the magnitude of the decisions based on statistics, it is essential that cancer incidence and mortality figures be as accurate as possible. In most parts of the U.S., cancer is not a reportable disease. This means that new cases of cancer are not always included in annual public health figures from the county and state level. National Cancer incidence data are therefore only estimates based on the data that are available from a small number of states. With this system of data collection, it is difficult for public health officials to identify trends in cancer incidence in different parts of the country and to determine potential environmental causes of cancer.

At the same time, those data that do exist may not always be suitable for comparison purposes. For example, estimates of cancer incidence in the early 70's were based primarily on data collected by the National Cancer Institute (NCI) from nine major areas in the U.S. In 1973, NCI expanded its data collection program to 11 population-based registries. As the American Cancer Society points out in the 1982 Facts and Figures (p. 4), "Each time a new data base is introduced to estimate the incidence of cancer, there may be sharp changes in figures due to the more accurate data. These changes do not indicate a cancer epidemic or new cure." It is important, therefore, to understand which data were used to develop the figures being compared, and to anticipate their potential limitations.

Data about cancer is inadequate, but data about exposure to carcinogens is even less adequate. A particular problem which arises when trying to link occupational exposure with certain cancers is the lack of adequate and accurate information about the individual's work history. A retired shipyard worker, for example, who spent his or her last five years as a security guard may report the latter as occupation. A more common problem is the situation in which a worker has been through many jobs of less than five years duration and yet only the last one is listed on his or her death certificate. Without information about previous jobs, the connection between an individual's early work exposure and his or her subsequent cancer may never be made.

V. Trends in Cancer Incidence and Mortality Rates

Because cancer is many diseases, not just one, it is important to review changes in incidence and mortality rates by specific types of cancer rather than by overall cancer rates. From data in the American Cancer Society Facts and Figures 1983 which review 25-year trends in cancer death rates, the two most striking changes are the 172 percent increase in lung cancer mortality among males and the 59 percent decrease in stomach cancer mortality also among males. Other specific sites of cancer which have changed over time include cancers of the breast, pancreas and uterus.

Although the primary sites of cancer do vary between men and women, the overall cancer incidence and mortality rates for the two sexes are fairly close.

This similarity is not true between races. Historically, cancer rates for whites have been higher than those for blacks. Recently, however, a rapid increase in both incidence and mortality rates for black males and black females has resulted in selected cancer rates for blacks which are higher than those for whites.*

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* Students should refer to the current American Cancer Society Cancer Facts and Figures, which graphically depicts trends in cancer morbidity and mortality.

The many possible explanations for the variations between races include differences in occupation, neighborhood location, dietary habits, accessibility to public health education and health care and statistical reporting of cancer rates. Discuss these and other factors that may be contributing to this difference (White, 1980, and DHEW Pub., See References #8 & 9).

STUDY QUESTIONS

Students should rely on lecture material and reading assignments to prepare the following study questions.

1. Many people feel that cancer is a disease of old age. Does the fact that life expectancy has risen in the U.S. over the past century account for the dramatic rise in the cancer death rate for the same time period?

2. What factors have contributed to the decrease in deaths from pneumonia and influenza, and to the rise in deaths from cancer since 1900?

3. Why is it important to estimate the national cancer incidence rate based on data from each state?

4. Why do you think that black Americans today have a higher cancer incidence and mortality rate than whites?

5. Is there a cancer epidemic in this country?

6. How would you overcome some of the difficulties of retrieving an accurate work history from records available?

7. In 1978, Love Canal became a name that epitomized for many people environmental disaster. The neighborhood again came before the public eye in the summer of 1982 as the question of the inhabitability of certain areas was raised.

    Arguments supporting both sides of the question of whether or not people should be allowed to move back into the Love Canal area are discussed in two articles in the New York Times. (Refer to references #3 and #4.)

    Read and review both of these articles and then develop a list of questions which you would want answered before deciding your own position on this issue. Bring these questions to the next class.

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Health-Hazard Survey Form

Local ______ Number of members in plant__________

Company ____________________ Major Products____________________

Address ____________________ ____________________

____________________ ____________________

(Fill in the appropriate spaces. Use the reverse side for comments or additional space.)

Date ____

Person filling out survey ______________________________

1. Department; Building number or name

2. Process

3. Chemicals used or produced

Trade or Common Name	Chemical Name
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

4. Are workers exposed to (identify them if you can):

Fumes ____

Dusts ____

Mists ____

Gases ____

Do chemicals get on or touch workers' skin? ____________________

Which chemicals? ______________________________

Do workers eat, smoke, or drink coffee or other liquids in the department? __________

____

5. Ventilation

Describe the ventilation system. ______

Do you think it is adequate? ______

Is the system performing up to design capacity? ______

Air-flow rate. ______

Is it regularly maintained and cleaned? ______

Is it used beyond its capacity? ______

Does the company check it periodically for air-flow rate? ______

6. Are workers exposed to these physical hazards?

Noise ______ Vibrations ______

Heat ______ Cold ______

Poor lighting ______ Humidity ______

Non-ionizing radiation (ultraviolet, infrared radiation, microwaves, etc.) ______

Ionizing radiation (X-rays, Uranium, etc.) ______

7. Monitoring

Which substances and physical hazards have been monitored? ______

Are personal and area monitoring done? ______

Are air samples taken? ______

Record the results, with the date. ______

Are there permanent monitoring devices for toxics? ______

Calibrated (date) ______

Level alarm set at ______

What additional measurements are needed? ______

Does the Union observe monitoring procedures? ______

8. Health complaints

Do workers complain about skin rashes, respiratory problems, headaches, stomach problems, eye irritation, dizziness, bloody noses, sores that don't heal, other problems? Be specific.

Do you know what the cause is?

Does the company perform any type of medical exam?

What does it include?

Do workers or their physicians receive the results?

Are the results explained to them?

9. Have health grievances or OSHA complaints been filed in this department?

Explain:

What actions does the committee recommend?

10. Have any accidents occurred in this department?

Explain:

11. Noise (fill in only if applicable)

Noise level

Date measured

Comments:

MODULE 2: A REVIEW OF THE MAJOR "CANCER THEORIES"

Lesson Objectives:

By the end of this session, students will be able to:

1. Describe the steps of scientific investigation.
2. Explain two views of how scientific theories are developed.
3. Discuss factors which limit the development of an accurate theory of what causes cancer.
4. Describe the evidence for and against the viral, genetic, and environmental theories of cancer causation.
5. Describe three aspects of the environment and how each affects the risk of developing cancer.
6. Explain how geographic variations and migration studies substantiate the environmental theory of cancer causation.

Special Terms:

Community
Environment
Science
Scientific Theory

Teaching Method:

Lecture
Class Discussion

Special Preparation:

Depending upon the students' science background, it may be necessary to briefly review how the link between a virus and a disease is determined before discussing the viral theory of cancer causation.

Review Material:

1. Review Module 1 questions; study question 7, based on the New York Times Love Canal articles will be discussed during the class. See page I-17.

2. Media Watch - Discuss findings from newspaper articles, TV and radio news coverage. Include the following questions from Module 1 in the discussion:
    a. What type of cancer is discussed?
    b. How many people are affected? Are any rates given?
    c. Is the cause of the cancer known?

3. Discuss any questions or problems students may have completing their Health Hazard Survey forms or contacting cancer resource agencies.

Assignments:

For all students:

1. Assign selected readings and study questions.
2. Media Watch:
    - Encourage all students to watch upcoming newsprograms that are relevant to the course.
    - Assign two students (See Module 1 assignments for specific instructions).

Workplace Assignment:

Have students complete any missing information on the Health Hazard Survey form.

Alternative Assignment:

Prepare a brief outline with information about services provided by each agency they contacted - educational, referral, testing, diagnosis, treatment services, etc.

MODULE 2: A REVIEW OF THE MAJOR "CANCER THEORIES"

I. Limitation of Science and Scientific Theory

A. Science: a General Perspective

With increasing frequency, scientists are asked to explain phenomena which are observed in a world of growing complexities. As technology expands and affects almost every aspect of life in industrialized societies, science (and specifically scientific theory) is having a greater impact on decisions which shape the course of society. Almost everyone in industrialized countries relies upon scientific theory in one form or another: policy makers, courts of law, large and small businesses, etc. As the demand increases for more and more scientific input into life's daily decisions, many demands are placed on scientists, some of which are very difficult to fulfill. For example, scientists are asked to help resolve complicated problems such as setting appropriate standards for radiation exposure. However, many questions surrounding the theory of how radiation affects health remain unanswered: What are the long-term effects of exposure to low-level radiation? Is there any "safe" level of exposure? etc. It is important to understand the inherent limitations of scientific thought before discussing the development of theories about what causes cancer.

Class Exercise:
Determining the class's own perceptions about science and its limitations can be an interesting way to develop this discussion. The following questions can be used for this purpose.

1. What is science?

2. What is scientific theory?

3. What are the limitations, which you can see, in utilizing scientific theory to set social policy?

While "science" can mean different things to different people, one common definition is that science is systematized knowledge derived from observation, study and experimentation, each carried out in order to determine the nature and principles of that which is being studied.

As this definition implies, science involves many things - it is a constellation of facts, theories and methods. In the pursuit of a strategy to explain events, scientists do three kinds of things: 1) they exercise imagination and creative insight; 2) they perform logical analyses and 3) they make judgments that are based on observations of the events that they wish to explain. The ultimate product of this process, the strategy for explaining events, is a theory, basically a proposal of how things work. To understand the strengths and weaknesses of current theories about cancer, it is useful to review some factors which have affected the development of science itself.

The development of science may be regarded from two perspectives:

a) "Development by Accumulation"
As Kuhn has noted, "if science is the constellation of facts, theories and methods collected in current texts..., scientific development becomes the piecemeal process by which these items have been added singly and in combination to the ever growing stockpile that constitutes scientific technique and knowledge" (1970, pp. 1-2).

b) "Development by Scientific Revolution"
There is an alternative perspective of science, however, to the process described above. In this perspective of scientific theory development, old theories are displaced by new ones when scientific research unearths new and contradictory evidence. An especially

famous illustration is the Copernican revolution in the 16th century. Before that time, Ptolemy's theories were the basis of astronomy. The Ptolemaic system, developed around the time of Christ, was based on the belief that the earth is at the center of the universe and that the sun, moon and planets revolve around it. However, by the early 16th century, there was growing recognition that the Ptolemaic system of astronomy was not able to explain and predict astronomical observations. The Copernican revolution, with its belief that the planets revolve around the sun, was an entirely new way of viewing the universe. Kuhn (1970) also presents a detailed description of the "scientific revolution" perspective of scientific development.

The most convincing argument in favor of the second perspective is the fact that scientists consider theories scientifically valid at one point, then later call those same theories error, superstition or myths. The first perspective does not explain why theories are rejected, but from the second perspective, this is a logical process. Since science cannot tolerate two competing explanations for an event, a new theory must displace a previous one in order to gain acceptance. This process, called scientific revolution, necessitates that the scientific community reject one time-honored theory in favor of another which is incompatible with it. This will often result in controversy among scientists, or even among politicians and policy-makers who advocate the rejection of a previously accepted theory or the adoption of a new one.

New theories and discoveries are often suppressed because they contradict the basic principles of science which are believed at the time. This is also true of scientific research. Through the 1960's, when it was commonly thought that cancer was caused by a virus, cancer research was devoted to the development of some form of Salk-type vaccine. In the 1970's, however, a shift took place in our view of cancer and its causes, resulting in much greater attention to the chemical and environmental factors. This type of shift does not occur easily since many individuals fear that an emphasis in one area will detract from the amount of visibility and research money devoted to a competing area.

B. Cancer Theories:

As a result of the increasing incidence of cancer in the U.S., scientists have been actively working to develop a theory to explain the causes of cancer based on what is known about the disease. Before discussing the most well-accepted theories of cancer causation, review the factors which may make it difficult to explain the problem of cancer causation by a specific theory.

1. Many diseases, not one: Although many people use "cancer" as a general term to describe a particular type of disease, cancer is, in fact, many diseases. Lung, pancreatic and breast cancer all affect a cell's genetic material (DNA) by causing uncontrolled growth which gives rise to tumors. In spite of this similar cellular process, the exact mechanism which causes the process to begin and the rate at which the process develops vary greatly depending on the type of cancer. Thus, a single theory about what causes cancer may not be sufficient.

2. Latency: The period of time between exposure to a hazard and the onset of disease may be as long as 40 years for some forms of cancer. In the community and industrial setting most people know very little about what they are exposed to. Even if exposures are initially identified, people often forget about the exposure, change jobs, retire, move to a different geographical area or change some personal habit (e.g. smoking or drinking). Further, it is very difficult to estimate the dose of exposure to substances used some 20-40 years prior to death. Without this type of information, proving cause and effect may be extremely difficult for the scientist. Our concern here is that inadequate data may cause a valid theory of cancer causation to be discounted.

3. Available data are limited: As discussed in Module 1, cancer data have significant limitations. Incidence rates, for example, are available from only a limited number of sources.

Mortality data are more accessible but may be affected by the availability and sophistication of medical and data collection services, etc. The result could be that uneven data collection techniques present a skewed picture of cancer distribution and thereby lead to an inaccurate description of the events to be explained by theory.

4. Statistics lack sensitivity: Conclusions about cancer causation are usually based on nationwide incidence and mortality statistics. Oftentimes variations at the local level are masked when the nation or even the state is considered as a whole.

   For instance, between 1976 and 1980, the incidence rate of invasive cancer of the cervix was 13.03/100,000 in New York State. A closer look at the figures shows that this rate is not consistent throughout the state. During the same period, the age-adjusted rate for Allegheny County, New York, was 21.5/100,000. The difference between these rates is statistically significant, a ratio of 1.65. Although the explanation for these differences may not be clear, knowing that the differences exist may help public health officials direct research efforts to the age groups with the particular problem.

5. Science and politics are not always separate: Although scientists are supposed to be neutral in their interpretation of data, personal factors such as how one's career has been built, one's associates within and outside of the scientific community, and where funding originates can bias scientific interpretation.

   Scientists should not be treated with suspicion nor should they be regarded as final authorities. Rather, the consumer, in this case the student, should learn how to question and interpret new information.

Class Discussion:

Review with the class the questions which were developed for Study Question 7 of the preceding Module. The discussion should take into account the potential impact of the five points made above on the conclusions drawn in these articles.

II. Review of the Theories

A. The Viral Theory:

For many years, scientists believed that viruses caused cancer. The viral theory seemed to make sense for a number of reasons. For example:

1. Since viruses are communicable, they can easily spread to susceptible persons. A viral agent would thus account for the wide-spread incidence of cancer.

2. Viruses cannot survive by themselves but must live inside other cells, using the energy from the host cell's metabolic processes. A viral agent could explain the abnormal behavior of cancer cells.

Only a few rare types of cancer have been linked to viruses. One example is the link between the Epstein-Barr virus (EB) and Burkitt's Lymphoma, a cancer of the lymph system found primarily in children living in a limited geographical area in Central Africa. Scientists confirmed the EB virus as the cause of Burkitt's Lymphoma by testing over 42,000 children in Central Africa for antibodies to EB virus (Edington, 1981).

After considerable research, however, scientists have found little evidence to support the viral theory for the majority of cancers.

Environmental exposures to cancer-causing chemicals and to radiation can also explain the wide-spread incidence of cancer and the abnormal behavior of cells.

B. The Genetic Theory

Does cancer run in families? Many people think that it does. Their experience with their families or with friends indicates that cancer tends to cluster. This implies a hereditary or genetic link. Recent data indicate that certain types of cancer do develop more frequently in some families. Cancers of the breast, stomach, large intestine, endometrium, prostate, lung and possibly ovary seem to cluster in families. It is not known, however, whether this clustering is due to genetic factors or to environmental factors. Families who live within the same neighborhood for generations may work at the same type of job for two or more generations. Those family members will have similar environmental exposures, making it difficult to distinguish between environmental and genetic effects.

As with the viral theory, only a small number of rare types of cancer can be explained by a genetic link. Childhood leukemia in twins and retinoblastoma, a rare cancer of the retina, are two examples that fit the genetic theory.

C. The Environmental Theory

1. The Environment - What is it?

After many years of research, scientists have come to agree that cancer is strongly related to the environment. The World Health Organization estimates that 70-85% of cancer is caused by the environment.

"Environment" is a very general term. The definition of environment and the contribution of environmental exposures to the overall cancer rate stimulate considerable debate in the scientific community. Three categories are usually considered when discussing the environment: Lifestyle factors include eating and smoking habits, alcohol and drug consumption, amount of exercise and stress; Environmental pollution includes air and water pollution and food product contamination; and Occupational exposures include exposure to chemicals, radiation and asbestos in factory and office environments. Lifestyle factors, environmental pollution and occupational exposures cannot be completely separated from one another. For example, an individual may be exposed to environmental pesticides on the food he or she eats. From the scientist's point of view, it is very difficult to isolate the effects of these factors from each other - the effects of smoking and air pollution, for example.

Although everyone is exposed to a certain amount of carcinogens in the environment or in food or water supplies, some people are exposed to much higher levels of carcinogens than others. Workers in certain industries (e.g. the asbestos and petrochemical industries) are affected by lifestyle habits and environmental pollution, as well as by high levels of carcinogen exposure at their workplaces.

2. Evidence for the Environmental Theory

Studies of geographical variations in cancer incidence and studies of migrant populations each substantiate the environmental theory.

a. Geographic Variations

Cancer is found all over. The chart, "Cancer Around the World" from the American Cancer Society's Annual Cancer Facts and Figures publication examines the range in cancer rates for various countries.*

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* See the current edition, available from the local ACS office.

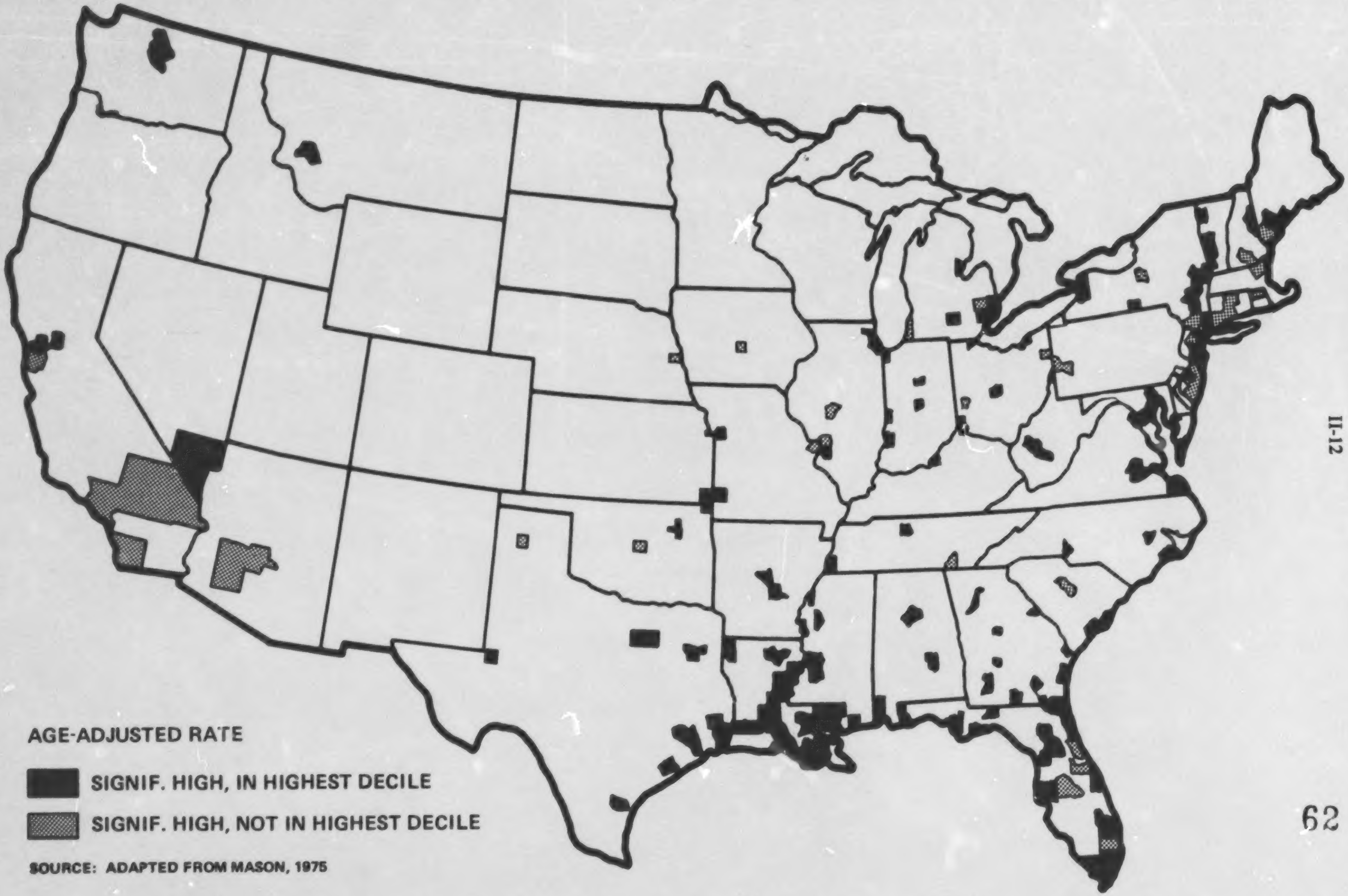
By identifying areas with a high rate of cancer and evaluating the environmental and cultural characteristics of those regions, some hypotheses about the causes of these variations can be formulated. For example, cancer of the mouth accounts for approximately 35% of all cancers in most Asian nations, but is rare in the West. A relationship between the Asian practice of chewing betel nuts and a high oral cancer rate has been hypothesized. High stomach cancer rates and the Japanese diet are also thought to be linked. The high rate of esophageal cancer in Brittany, France and the consumption of an applejack drink brewed in the area is another example.

In the U.S., a series of "Cancer Maps" has been developed which portrays cancer mortality by county. Occupational exposure to carcinogens can explain variations in cancer rates in some areas of the country. Figure 1 shows a map depicting the geographic areas where mortality from cancer of the trachea, bronchus and lung among white males is significantly higher than in the rest of the population. Mortality is excessive in a belt of counties on the southeast Atlantic Coast, in northern New Jersey, New York City, and along the Hudson River. Excessive mortality, however, is not limited to highly populated urban areas where cigarette smoking and air pollution are most prominent. In fact, the rates are highest along the Gulf Coast from Texas through Florida, with the heaviest concentrations in Louisiana.

Based on this map and on a knowledge of the important industries in those areas, one can explain the variations; the factors that contribute to the excess cancer mortality are asbestos use in the shipbuilding industry and the presence of many petrochemical plants (Mason, 1970).

b. Migration Studies

Migration studies compare the cancer rate of an ethnic group in its native land with the rate of the same ethnic group in


AGE-ADJUSTED RATE
■ SIGNIF. HIGH, IN HIGHEST DECILE
▨ SIGNIF. HIGH, NOT IN HIGHEST DECILE

SOURCE: ADAPTED FROM MASON, 1975

Figure 1. Trachea, Bronchus and Lung Cancer Mortality 1950–69, by County, White Males.

another area of the world. These studies have given the most support to the environmental theory. A classic example is a study which compared cancer incidence rates of Japanese in Japan with those of Japanese in Hawaii. The rate for stomach cancer in Japan is quite high. For men, in 1966, the figure was 93.9 per 100,000. However, the incidence for Japanese men living in Hawaii was half of that for the years 1960-1964 - 47.6 per 100,000. This figure is close to the rate observed among native Hawaiians - 45.9 per 100,000 (Hicks, 1980).

If stomach cancer was caused by genetic factors, one would expect the cancer rate of the Japanese to be similar in Japan and in Hawaii. The evidence, however, leads one to look to enviromental causes to explain the variation in rates.

Another migration study compared cancer rates among U.S. blacks with blacks from Nigeria and from other areas of Africa. According to the authors' sources, 75% of black Americans are of West African origins, 40% from the region which is now Nigeria. However, with very few exceptions, American blacks have higher cancer incidence rates. For example, as compared to cancer rates in Ibadan, Nigeria, cancer rates among U.S. blacks are three times higher for men and twice as high for women (Young, 1975).

c. Community Studies

Up until this point, we have talked about cancer variation by geographical location. Communities are not always defined by geographical boundaries. Ethnic origin, religion and economic status all define communities of one sort or another.

Comparisons between various religous groups within the same locality have revealed differences in cancer rates. For example, the Mormons of Utah, the Seventh Day Adventists, and the Mormons of California experience low incidence rates for cancer of the respiratory tract, gastro-intestinal tract and genital system. The variations in these rates may be attributed to the lifestyles of these groups. Mormons and Seventh Day Adventists do not smoke, drink alcoholic beverages, or use drugs. Many Seventh Day Adventists also have a different diet from that of most Americans (Cairns, 1980).

In summary, the dominant theory of cancer causation has changed over time from the viral to the environmental theory. However, because cancer is really many diseases (with a similar disease process), the environmental, genetic and viral theories may all be necessary to adequately explain cancer. Future cancer research may both add to our present knowledge and unearth new evidence that will necessitate replacing current theories with new ones. Module 3 describes what is currently known about the disease process that is called "cancer."

STUDY QUESTIONS

1. What is a "scientific theory?" What purpose does it serve?

2. What are some of the problems associated with developing a scientific theory of cancer causation?

3. "The cancer rate in the U.S. is decreasing."
   How does the fact that cancer is many diseases, not just one, affect your acceptance or rejection of this statement?

4. Briefly explain the three major theories of cancer causation, including their major strengths and weaknesses.

5. What are some problems which occur when scientific theories are used to develop social policy?

Module 2

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MODULE 3: PHYSIOLOGY, SCREENING AND TREATMENT OF CANCER

Lesson Objectives:

By the end of this session, students will be able to:

1. Explain the difference between primary, secondary and tertiary prevention programs.
2. Describe the basic principles of cancer physiology at the cellular and organ levels.
3. List the early warning signals of cancer.
4. Explain how cancer screening tests are used as a secondary form of cancer prevention.
5. Identify and describe the most frequently used cancer treatment methods.

Special Terms

Benign
Carcinogen
Carcinoma
Homeostasis
Latency period
Leukemia
Malignant
Metastasis
Mutagen
Primary and Secondary
Remission
Sarcoma
Screening tests
Sensitivity
Specificity
Survival rate
Tumor

Teaching Method

Lecture
Class Discussion
Audio-Visual Presentations

Special Preparation

1. Review Lesson 1 of the American Cancer Society's Nature of Cancer teaching kit for senior high school classes. It contains visual aid material useful in the discussion of cellular replication.

2. The American Cancer Society offers two films, "The Embattled Cell" and "From One Cell" which describe cancer cell development. Either one of these films will be useful when presenting the material for this Module. Both films should be previewed and the one chosen which most closely matches the students' science background. (See References # 1 & 2.)

Review Material:

1. Review Module 2 study questions.

2. Review Media Watch articles. Discuss questions from Module 2:
   a. Do the articles attribute cancer to a specific cause?
   b. If so, do the examples collected fit either the viral, genetic or environmental theory of cancer causation?
   c. What proof is there to substantiate a specific theory?

Assignments:

1. Assign selected readings and study questions. Specified students should prepare material for the debate described in Study Question #4. The debate can either be scheduled for the next class session or for the following, depending upon the degree of preparation expected.

2. Assign two students to the Media Watch. They should develop a list of additional pieces of information which might be desired before agreeing or disagreeing with the point of view in the article. The list of questions can be expanded in the class discussion at the next session.

3. To help students become more aware of the chemicals used in their own lives, ask them to bring into class labels from three substances used at home and at work which contain chemicals. List the chemical names on a chart and place the chart in a visible location for a discussion of which on the list are known carcinogens.

MODULE 3: PHYSIOLOGY, SCREENING AND TREATMENT OF CANCER

I. Introduction*

The early detection of cancer is an essential prerequisite to successful treatment. Different types of cancer may represent different diseases, but the similarities in the stages of cancer development enable us to develop screening tests that will detect cancer in its early stages.

Although screening and treatment programs do not prevent the development of cancer, they are preventive in the sense that they attempt to prevent cancer from spreading. Cancer prevention programs fall into three categories:

Primary Prevention: Primary prevention prevents cancer from developing and can take two approaches: 1) Promoting people's overall health to make them less susceptible to disease by providing them with the necessities of life (food, clothing, shelter, etc.), immunizing people against certain transmittable diseases, educating them about improved eating habits and smoking cessation techniques, and providing weight reduction and exercise programs. 2) Controlling environmental exposures by eliminating the source of the problem before it causes damage. Environmental control includes programs to purify water supplies and to eliminate safety hazards or disease-producing substances from the workplace and the environment.

Secondary Prevention: Secondary prevention is not prevention in the true sense of the word. Rather than actually preventing cancer from occurring, secondary prevention programs use screening tests to detect disease in the earliest possible stage. Once diagnosed, the person's illness can then be cured or treated to keep the disease from spreading, prevent complications and prevent or limit disability. Examples of secondary cancer prevention programs are tests for colon and rectal cancer, breast self-exams to detect breast lumps and annual PAP smears to detect potentially cancerous changes in cells of the cervix.

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*At this point in the course, students may become anxious about medical/scientific terminology. Those with little scientific background may tend to use general or conceptual terms. Since one of the course's goals is to break down students' resistance to using scientific information and jargon, it is important that students continually use the new terms in classroom discussion and in homework assignments. This will assist them in later communication exercises.

Tertiary Prevention: Tertiary prevention, usually referred to as tertiary care, occurs in the advanced stages of the disease and attempts to limit disability by preventing further complications. Rehabilitation programs provide medical, psychosocial and vocational services to help the individual best utilize his or her remaining abilities.

This module examines secondary cancer prevention programs and remaining modules focus on primary prevention efforts to control cancer-causing substances. The screening tests used in secondary cancer prevention programs can best be understood after cancer physiology is briefly explained.

II. Cancer Physiology

A. Cellular Replication

Audio-Visual Presentation

Refer to Lesson 1 of the American Cancer Society's Nature of Cancer teaching kit and show either of the American Cancer Society's two films - "The Embattled Cell" or "From One Cell."

A review of cellular replication should include the following basic points:

1. The growth of the human body involves three cellular processes - cell division, cell growth and cell differentiation. These processes occur rapidly during childhood and continue at a slower rate during adulthood to replace damaged cells or those that have a short life span.

2. Cell division occurs in two steps - chromosomal replication and cellular division. The first step is the division of the cell's genetic material. The genetic material (DNA) is on strands which replicate themselves to form identical strands called chromosomes. After the genetic material has been duplicated the second step proceeds - the cell divides into two daughter cells, each containing a copy of the original DNA from the parent cell.

3. Mistakes sometimes occur in the process of DNA replication. Any change in the genetic message carried by the cell's DNA is called a mutation. Although rare, these changes can have serious consequences for the body's ability to function. When a mutation occurs in the sperm or egg cell, it is passed on to the developing child and can cause a spontaneous abortion (miscarriage) or a birth defect. Mutagens are environmental substances that increase the rate of genetic mutations. Examples of mutagens include certain chemical substances such as vinyl chloride used in plastics manufacturing, chloroprene used to manufacture synthetic rubber, and certain forms of ionizing radiation such as X-rays and atomic radiation.

4. Cells divide at different rates - rapidly growing cells divide about once every 24 hours while other cells may only divide once every few weeks or months. For example, cells in the intestine are replaced every 24 hours, while adult muscle or nerve tissue cells are rarely replaced.

5. Cells function together to form tissues, organs and organ systems. Cellular division among normal cells is well synchronized so that the organization of cells into the body's tissues and organs (liver, lungs, heart, etc.) is maintained. A very definite balance, or homeostasis, must be maintained if the body is to function normally.

As we understand it now, cancer is the uncontrolled growth of cells. When the cellular genetic material is altered in some way, cells lose their ability to divide normally and to function in harmony with other cells. The uncontrolled growth of cells eventually results in a mass or tumor which can affect specific organs, organ systems or the entire body.

B. Tumors

Tumors may be benign (noncancerous) or malignant (cancerous). Although confusion often arises because some scientists and medical professionals refer to both types of tumors as cancer, the term cancer is generally used to refer to malignant tumors.

Benign tumors have the following characteristics:

- Slow growth
- Encapsulated - walled off from surrounding tissue
- Localized - do not invade normal surrounding tissue
- May exert pressure on surrounding tissues or organs but can be easily removed by surgery

Examples of benign tumors are moles, warts, cysts, and uterine fibroids.

Malignant tumors differ considerably from benign tumors:

- Rapid growth
- Cells lose their ability to differentiate - to develop into cells with specialized functions. They bear little resemblance to cells in the surrounding tissue, cannot work together with neighboring cells and so cause the organ to malfunction
- Invade and destroy surrounding tissue
- Metastasize - invade the circulatory system and spread to other regions of the body
- Difficult to treat once metastasis occurs

Tumor growth and development varies depending on the type of tumor. Several factors influence the severity of the cancer and the chance of successful detection and treatment:

- Rate of tumor growth - even benign tumors can cause problems if they grow large enough to exert pressure on other organs such as the brain
- Frequency of metastases - some tumors may grow very large without ever metastasizing and others may metastasize before the original tumor is detected
- Site of metastases - lung cancers often metastasize to the brain, breast cancers to the bones and lungs and large intestine cancers to the liver. These cancers are all very difficult to treat successfully.

Tumors are usually named for the types of cells from which they arise. Three major categories of tumors are carcinoma, leukemia, and sarcoma. LeServe describes these as follows (p. 26):

> Carcinoma - If the malignant tumor is composed mainly of epithelial cells, the cells which cover the outer or inner surfaces of the body (skin, lung, stomach, etc.), it is known as a carcinoma.
>
> Sarcoma - If a tumor develops from connective tissues, muscle, bone, etc., it is called a sarcoma.
>
> Leukemia - A group of malignant cancers which are not characterized by a solid tumor are the leukemias. For example, tumor cells that develop in the bone marrow (the site of blood cell formation) circulate in the bloodstream.

Although cancer is many diseases, each type progresses by a disease process that is similar enough to permit the identification of certain changes that may indicate cancer.

III. Diagnosis

Cancer may not be suspected until physical problems appear or it may be detected earlier by microscopic tests which identify abnormal cell changes. The physical symptoms of cancer are also similar to health problems caused by other diseases and do not necessarily indicate cancer. The American Cancer

Society recommends that, to be safe, any of the following symptoms which lasts longer than two weeks should be examined by a physician who will investigate the cause. The acronym CAUTION can be used to remember the seven warning signals:

C hange in bowel or bladder habits
A sore that does not heal
U nusual bleeding or discharge
T hickening or lump in breast or elsewhere
I ndigestion or difficulty in swallowing; unexplained or sudden weight loss
O bvious change in size or color of wart or mole
N agging cough or hoarseness

If any of these symptoms is a result of cancer, it will appear only after the disease has progressed far enough to cause health problems. Malignant tumors release chemicals which can affect surrounding tissues, cancerous growth invades nearby blood vessels and can cause abnormal bleeding, and tumor growth can obstruct passages or put pressure on tissues or organs. The specific symptoms will differ depending on the tumor's location:

- cancer of the colon or rectum - changes in bowel habits
- skin cancer - persistent sores
- reproductive organs and rectal cancer - bleeding or discharge
- breast cancer - lumps
- stomach cancer - indigestion
- laryngeal cancer - difficulty in swallowing
- lung cancer - coughs and hoarseness

Familiarity with one's body is an important component of preventive health care. People who are comfortable observing their own body's way of functioning will be aware of the difference between normal and abnormal changes. When they do detect potentially abnormal changes, they can knowledgeably consult a health practitioner before a serious problem develops.

Early Diagnosis

Tests to detect cancer in the earliest possible stage attempt to diagnose the disease before rapid, widespread damage can occur. The earlier the diagnosis,

- the less chance of damage to the surrounding tissue;
- the better the chance that the tumor has not metastasized;
- the better the chance that the primary tumor can be removed by surgery.

Some tests are simple enough for individuals to do themselves. The breast self-exam for women is a well-known example and illustrates the need for knowledge about one's body. Most women have some breast lumps that change in size during the menstrual cycle. A woman who is not aware that her breasts normally swell before her menstrual period may become unnecessarily concerned about breast changes. However, neither the lumps nor the changes indicate a problem if they are normal for that woman. Thus, it is important that the woman regularly examine her own breasts at the same time each month and consult a health practitioner if she detects a lump that is larger than normal or that persists for longer than normal. The American Cancer Society is now also advocating testicular self-exams for men. Early detection and biopsy of breast or testicular lumps enables the identification and easy removal of malignant tumors before they metastasize.

Other tests which assist the physician or health practitioner in cancer's early diagnosis include periodic lung X-rays of asbestos-exposed workers, microscopic examination of sputum, skin and mouth inspection, Pap tests and CBC (complete blood count) tests. The Pap test and breast self-examination appear to have been successful in identifying cancer earlier among a large group of women (Baker, 1982). However, early diagnosis is not always possible because:

- Symptoms are not always present at the early stages of growth.
- Symptoms which do occur are often vague and can also be associated with other diseases.

- Technology may not currently be available to detect the cancer before it metastisizes.
- Even when a successful test exists, its effectiveness may be curtailed by limited use. For example, early diagnosis of bowel cancer increases survival rates. However, testing is very rarely done in occupational settings such as asbestos industries where workers are exposed to carcinogens (Levin, 1982).

Screening Tests

The tests mentioned above are known as screening tests. They can be useful in detecting cancer in its early stages but do not give a definite diagnosis. Screening tests are only tools which help determine which seemingly healthy people probably have cancer and which probably do not have cancer. For example, Pap tests are microscopic examinations of cells taken from the cervix which can identify abnormal cell changes. Results are then categorized into Classes I-V based on the severity of the cell changes. Each classification indicates the probability that the cells might be precursors of cancer cells: A Class I result means the cell looks normal, Class II cells frequently revert back to normal Class I cells, Class III results indicate a greater chance that the cells will progress to cancer and should be followed by further testing, etc.

A serious problem with screening tests is that they may not be accurate enough to detect as cancerous all the abnormal changes that will eventually lead to cancer or they may detect as cancerous some temporary changes that will automatically revert to normal. Tests that cannot accurately detect cancerous changes have poor sensitivity; sensitivity is defined as the ability of the test to correctly identify those who have the disease. Specificity is the ability of a test to correctly identify those who do not have the disease. A test that identifies normal, temporary physiological changes as cancerous has poor specificity.

The accuracy of the testing procedure has important implications for the success of screening programs. A test that cannot identify cancer is of no use, but a test that incorrectly identifies every change as cancer creates other problems: each person with a positive result must undergo further, possibly expensive testing and may be unnecessarily subjected to the psychological trauma often associated with a diagnosis of cancer.

The success of cancer screening programs depends on several factors:

1. Tests must be as accurate as possible with both high levels of sensitivity and specificity.
2. Programs must avoid the ethical problems of telling people they have cancer when they don't (a problem with tests that lack specificity).
3. Testing should be as painless as possible.
4. Early cancer detection must have definite benefits. For some cancers, such as lung cancer or mesothelioma, periodic X-ray screening tests have had little impact on improving an individual's chances of survival. In these cases, does early detection have a positive or a negative effect on the individual? If scientific advances have not made some kind of therapy available for those diagnosed as having cancer, early diagnosis through a screening program may have negative effects on the individual's psychological and physiological health.
5. If therapy is available for a specific type of cancer, the therapy's benefits must outweigh the costs to the individual of the anxiety associated with a diagnosis of cancer.
6. Diagnostic, therapeutic, education and counseling programs must be implemented in conjunction with screening programs.
7. Screening programs must be relatively low cost and easily administered.

A major challenge for scientists today is to develop screening tests which identify changes in the body at an early stage - in the beginning stages of abnormal cellular function. Several of the tests presently available, including the Ames test (Salmonella microsome test) and chromosomal abberation studies, are reviewed in Module 7.

IV. Cancer Treatment*

The scientific and public press furiously debate the most effective mode of cancer treatment. It is not within the scope of this course to discuss in detail the various types of treatment available today. However, a brief overview of the field will be presented.

A. Traditional Medical Treatments

Traditionally, there are three types of cancer therapy - surgery, radiation, and chemotherapy (drug therapy). Surgery is the oldest and preferred method of treatment for most cancers, and is the method which claims the greatest success. Surgery is most often used with primary tumors - tumors which have not yet spread. Once the tumor metastasizes, surgery is no longer effective. Potential side effects include changes in hormonal balance when surgery is done in a hormonally sensitive part of the body such as the ovaries or the thyroid.

Radiation Therapy uses highly concentrated doses of energy in the form of X-rays, cobalt and radium to kill cells. Radiation is often used as a post-operative cancer treatment or sometimes to shrink tumors before surgery. Radiation is most effective on the more dangerous cancers - those that reproduce the fastest. Early Hodgkin's disease and certain forms of leukemia are very responsive to radiation therapy, and survival rates have improved markedly with its use in the last few years. Radiation may be given externally as in X-rays; or it may be administered internally, by implanting radioactive substances into either the tumor or a body cavity. The significant disadvantages are radiation sickness - nausea, sometimes vomiting, lowering of white and red blood cell count, pain and drying of the mucosa of the mouth, pharynx, bladder and rectum. Long-term reactions may include kidney failure, interference in bone development in children, sterility, and birth defects. Radiation is effective therapy because it can kill cancerous cells. However, it can also cause mutations in normal cells. Ironically, one side effect of radiation treatment is the threat of developing secondary cancer 20-30 years later as a result of the treatment itself. The toxicity of radiation therapy is greatly increased when used in combination with chemotherapy.

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*Much of the material in this section has been taken from Health Facts, 1979. (See Reference #10.)

Chemotherapy is the process of treating cancer with chemical agents designed to kill cancer cells or to halt their further growth. This form of therapy began in the 1940's and has led to dramatic cures for some forms of cancer. For example, five year disease-free periods have been reported in children treated for acute lymphocytic leukemia; a variety of other tumors also respond well to these drugs. Chemotherapy is used for systemic cancers such as leukemia because cancer-killing agents can reach all parts of the body by flowing throughout the bloodstream. Although the chemical composition of these drugs varies tremendously, a similarity between them is that they all act by interfering with the cell's ability to reproduce. The major disadvantage of chemotherapy is that most drugs interfere with the body's immune system and so destroy the person's ability to fight off disease. Approximately 25% of the patients treated by chemotherapy in National Cancer Institute clinical tests died from drugs rather than cancer.

B. Non-traditional Medical Treatments

In addition to the traditional treatments for cancer, a variety of non-orthodox cancer therapies are gaining public and scientific attention. Laetrile, a substance derived from apricot pits, is perhaps the best known of the non-traditional treatments. There is not, however, acceptable scientific evidence of Laetrile's effectiveness. Based on individual testimony and anecdote, Laetrile has nonetheless attracted a following. Health Facts reports that an estimated 10% of all persons who are undergoing cancer treatment are taking some form of Laetrile.

Dietary and Lifestyle Changes: Nutrition therapies are currently a popular form of non-traditional therapy. These therapies vary from an all natural foods diet to high dosages of vitamin C, as advocated by two Nobel Prize laureates, Linus Pauling, Ph.D. and Albert Szent-Gyorgi, M.D., Ph.D. The natural foods diet eliminates sugar, coffee, tea, table salt, preservatives, additives and red meat. It emphasizes whole grains, legumes, fresh vegetables, "live" uncooked foods and sprouts, and strictly limits refined carbohydrates such as white flour, white rice, etc. These nutritional approaches are holistic in the sense that the entire body system is treated. Diet, stress, sedentary life style, and chemical substances in food and in the environment are all considered contributors to the development of cancer, and are all targets for change. Proponents of this approach do not view cancer as a tumor disease but rather as a metabolic malfunction which may be corrected when diet and lifestyle are brought into a healthy balance.

Finally, there are psychological approaches to cancer treatment. Since the 18th century, observers have noted that the development of cancer was frequently preceded by an adverse life event. Research has demonstrated that cancer symptoms are more likely to show up between six and eighteen months after some traumatic loss such as the death of a loved one or the loss of a job, or after some other major misfortune. Some psychologists and clinicians have used psychic power to develop treatments which make positive use of the body's mental power to cure itself. Simonton et al. (1978) have explored visualization techniques in which patients use mental imagery to fight cancer cells. Norman Cousins and his use of laughter therapy is another example of this type of therapy. Cousins, diagnosed as having an often incurable form of cancer, undertook a course of nutrition therapy coupled with a plan which would assure at least one good, deep belly laugh a day. To accomplish this, Cousins rented all the old Marx Brothers films he could find. Although remission for his form of cancer is rare, Cousins has been in remission since 1977 (Cousins, 1980).

Immunotherapy is a recognized experimental area that has not yet reached definite treatment status. It attempts to aid and stimulate the body's own immune system to overcome cancer by injecting small doses of live cancer cells or a live strain of bacteria (Bacillas Calmette Guerin, BCG) formerly used to vaccinate against tuberculosis.

Cancer treatment takes an emotional toll on its victims. Most cancer victims experience an agonizing, disabling and socially stigmatized disease (Sontag, 1978). Fear and depression are common among cancer victims. Many fear the treatment as much as the disease. The hospice movement around the world has attempted to respond to this emotional burden by emphasizing the human side of cancer treatment and the rights of victims and their families to let a patient die with dignity.*

Resources for providing accurate information on cancer treatment or on counseling cancer victims are becoming more available throughout the country. For example, in New York City, Sloan Kettering Memorial Cancer Institute sponsors a cancer information telephone hot line.

> Class Discussion:
> Review the information students collected about the activities of local cancer information and referral agencies. Students should present information about the agency they contacted, describing the kinds of services provided - education, referral, screening, diagnosis and treatment, etc. For each service, have the class determine whether it is primary, secondary or tertiary prevention.

Survival

Cancer survival is discussed by the medical profession in terms of survival rate, the number or percentage of people living for a certain number of years after the disease is diagnosed and treated. Five-year survival rates are the most commonly used indicator. Twenty-five years ago, only one in four cancer victims survived more than five years. Today 41% of cancer patients will survive at least five years.

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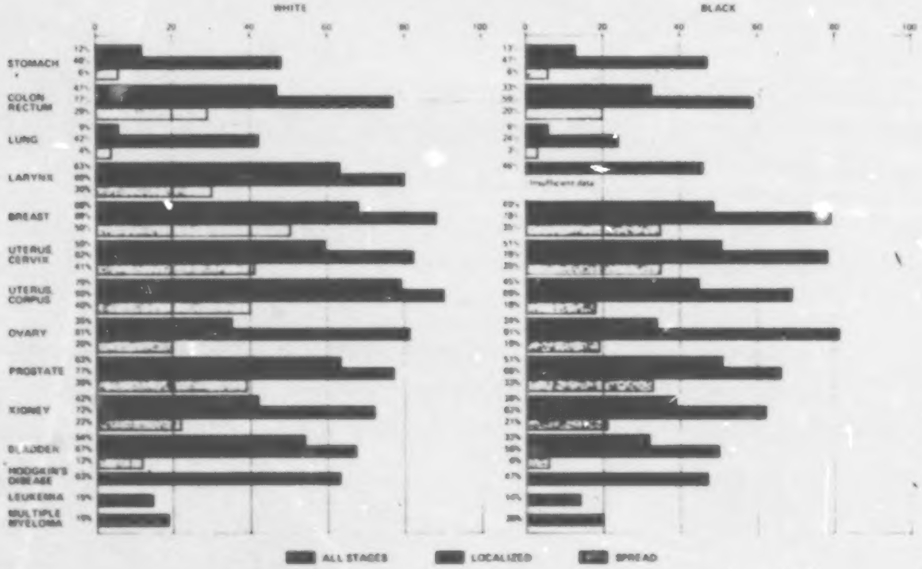
*Elizabeth Kubler-Ross presents a sensitive treatment of this important aspect of cancer in her book, On Death and Dying. (See Reference #12.)

Survival rates vary considerably depending upon the type of cancer. Over the past twenty years, considerable progress has been made in improving the 5-year survival rates of certain cancers such as Hodgkin's disease, testicular cancer, and acute lymphocytic leukemia. These cancers, however, are quite rare. For the major killers, such as lung and breast cancers, the 5-year survival rates have changed very little over the past decade.

Early diagnosis can dramatically improve an individual's chance of surviving cancer for five years or more. The earlier the diagnosis, the more localized the tumor, the more effective the treatment and the better the chance of surviving. Data in Table I illustrate these statistics for different types of cancer. The data show clearly that five year survival rates are greater when the cancer is a localized tumor than when it has spread; they also illustrate significant variations between different kinds of cancer.

Table 1: Five-Year Cancer Survival Rates* For Selected Sites



* Adjusted for normal life expectancy
Source: Biometry Branch, National Cancer Institute (Taken from American Cancer Society, Cancer Facts and Figures, 1983).

Class Exercise:

Using Table 1, compare the 5-year survival rates for cancer of the uterus and for cancer of the lung. What do these figures imply about the effectiveness of early detection of these two diseases?

Evaluating Cancer Treatment

Survival rates are often given as a measure of the effectiveness of a particular screening or therapy program. We assumed in the discussion of survival rates that improved rates are a result of treatment at an earlier stage. However, one very important question arises: does the person actually live longer or are we just diagnosing the cancer earlier so it appears that he or she is living longer?

Since survival is measured from diagnosis to death, an increased survival rate could mean one of two things. It could mean that the lives of those individuals who received treatment were prolonged because the treatment is truly effective. Or, it could simply mean that the disease was diagnosed earlier and that the treatment did nothing to prolong life.

Quality of life is another important issue when evaluating the effectiveness of diagnosis and treatment programs. Survival is not synonymous with cure and may not be an appropriate measure of success. Another indicator of success is the length of the remission period - the length of time after treatment without recurring symptoms. Diagnosis and treatment are also considered effective if the remission period increases.

In summary, the earlier the cancer is diagnosed, the more effective the treatment. However, at the present time we cannot eliminate the disease itself; therefore, controlling exposure to carcinogens is the only logical way to prevent cancer from occurring. Module 4 discusses theories that attempt to explain how environmental carcinogenic substances cause cancer. The remaining modules then discuss ways to control carcinogen exposure.

Module 3.

STUDY QUESTIONS

1. Why is early diagnosis essential in reducing cancer mortality?

2. "Primary cancer prevention programs prevent cancer incidence. Secondary cancer prevention programs prevent mortality." Explain this statement.

3. There is considerable debate among the medical profession concerning the best treatment for breast cancer. Radical mastectomies have been the traditional surgery used for breast cancer. Many doctors today believe that more limited forms of surgery are equally successful with far less trauma to the patient. Review this debate and summarize the key issues involved. You may want to start with Hugh Drummond's article, "The Best Available Treatment." (See Reference #7.)

4. Class Debate:
While there is general agreement that the environment contributes from 75-85% of all cancer, there is tremendous debate about which environmental factors contribute the most to the increased cancer risk. Epstein and Swartz (Reference #8) believe that carcinogens both at work and in the environment contribute significantly to the overall cancer rate. Peto, (Reference #14) vigorously disagrees, claiming that factors in an individual's lifestyle, such as diet, exercise, and smoking contribute the most to an individual's risk of cancer while carcinogens in the environment and at work contribute to a very small degree.

   Once the importance of environmental factors in carcinogenesis is acknowledged, the issue becomes whether to focus on factors over which individuals have immediate control or on those exposures which require solutions in the political and scientific arenas. To develop this question fully, assign a group of students to prepare a debate based on the articles by Epstein and Swartz and by Peto.

The following questions may be useful to students preparing their arguments:

a. Is it possible, in this complex world, to separate out and give percentages to how much each environmental factor actually contributes to the overall cancer risk?

b. Given the limitations of cancer statistics discussed previously, can such predictions be made with much accuracy?

c. What types of preventive action are suggested by each theory? Should action be primarily individual or group-initiated changes, medical, or political and economic change?

References #6 and #9 are also useful articles for the debate.

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MODULE 4: CARCINOGENS AND CANCER

Lesson Objectives:

By the end of this session, students will be able to:

1. Explain the initiation and promotion theories of cancer causation.
2. Using the list of known carcinogens, describe which workers are at greatest risk of exposure to different categories of carcinogens and which cancers those carcinogens are associated with.
3. Explain the relationship between the dose of carcinogen exposure and the risk of developing cancer.
4. Explain the safe threshold and the no safe threshold level theories of carcinogenesis.
5. Describe the characteristics of the carcinogen, the environment and the individual which influence how the carcinogen affects an individual's health.
6. Describe several routes of entry of carcinogens into the body.
7. Describe the body's defense mechanisms.

Special Terms:

Agent
Carcinogen
Cocarcinogen
Complete carcinogens
Dose
Dose/response
Host
Incomplete carcinogens
Initiation
Latency
No-safe threshold level
Promotion
Route of entry
Threshold level

Teaching Method:

Lecture

Class Discussion

Small group discussion (see page IV-6,7). Have the class break into small groups on the basis of similar kinds of work/working conditions. Each group should use its Health Hazard Survey forms and the Table of Carcinogens (Appendix A) to compile a list of carcinogens to which group members are exposed together with the types of cancer associated with those carcinogens. The notes from each group should be kept in an on-going file for future use. At each session, the group should appoint different people to chair the discussion and to take notes.

Review Material:

1. Review study questions from Module 3.

2. Review the Media Watch articles; the students assigned at the last session should lead the class discussion about additional information needed in order to determine whether they agree or disagree with the article's points of view.

3. Review and list the chemicals from the labels brought to class.

Assignments:

1. Assign selected study questions and readings. Explain Study Question #3, conducting taped interviews, as discussed on page viii in the section "Structure of the Curriculum."
2. Assign two students to the Media Watch project.

I. Introduction

Many factors work together to determine whether an individual will develop cancer. There are three environmental sources of carcinogen exposure: the workplace, the community (environmental pollutants) and the individual's personal habits (lifestyle factors). People often assume that cancer strikes randomly and that everyone has an equal chance of getting cancer. However, the risk of developing cancer varies for different groups of people because they are exposed to different levels of environmental carcinogens. Workers using carcinogens and people living in the communities around those worksites are at greatest risk. When combined with lifestyle factors, the risks from workplace and community carcinogen exposure are greatly inreased. This module explores the relationship between carcinogen exposure and the body's response.

The industrial production and corresponding exposure of the population to chemicals and radiation is rising in the U.S. NIOSH estimates that over 60,000 chemicals are currently in common use throughout American industry and 3,000 chemicals are developed every year. This trend is not new. From 1945-1970, production of synthethic fibers increased by 5980%, plastics by 1960% and nitrogen fertilizer by 1050% (Epstein, 1978).

Radiation is also used in an increasingly wide variety of applications: medical treatment and research, nuclear power, and consumer products. With this proliferation, U.S. government figures estimate that the number of American workers exposed to ionizing radiation at their jobs jumped from 460,000 workers in 1960 to 1,106,900 in 1975 (U.S. EPA, 1981).

II. Which Substances Cause Cancer?

Carcinogens can be classified as biological, physical, or chemical agents. There are few known biological agents; a noted example is the Epstein-Barr virus (EB) which was linked to Burkitt's Lymphoma, a cancer of the lymph system found in Central African children.

Radiation is the best example of a physical carcinogen. The physical properties of radiation allow it to penetrate certain substances and cause physical damage.

Many cases of cancer linked to chemical exposure have been observed in the last two centuries, causing scientists concern that the rapid rise of cancer is somehow linked to the proliferation of chemicals throughout our workplaces and the environment. Scientists' greatest fear is that because of the 20-30 year latency period of some cancers, we may only be seeing the "tip of the iceberg" of chemically-induced cancers.

> Class Discussion:
>
> Many people believe that a large enough dose of any chemical or any type of radiation can cause cancer. Ask the class for examples of this belief and of its effect on people. During the discussion, stress that this is really a myth and a simplistic approach to a complex problem. Although much is still unknown about the possible carcinogenicity of many substances, believing that everything is carcinogenic is untrue and may make the problem of carcinogen control seem so overwhelming that people would rather throw up their hands in despair than attempt a solution.

A. Chemicals

Although the number of chemicals identified as positive or suspect carcinogens is increasing, all chemicals and all forms of radiation do not cause cancer. Many chemicals that are structurally similar to carcinogens are not carcinogenic themselves. More than 6,000 chemicals have been tested, most by animal tests, the primary method of testing for carcinogenicity. So far, all of those chemicals found to cause cancer in humans have also caused cancer in animals. However, not all chemicals that cause cancer in animals do so in humans. Only 26 have been identified as carcinogens in human populations and another 63 chemicals have been associated with cancer. These 63 suspect chemicals are "substances that show sufficient evidence of cancer causation in experimental animals and are reasonably anticipated to be carcinogenic in humans" (U.S. DHHS, 1981).

Other chemicals widely used throughout industry are not proven carcinogens but are being studied for their potential to cause cancer.

Anesthetic waste gases such as halothane, nitrous oxide, and methoxyflurane are found in hospital operating rooms and are suspected of causing leukemia and lymphoma among operating room employees.

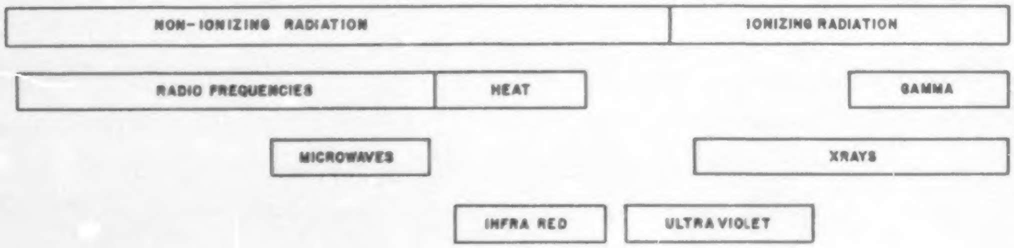
Synthetic cutting oils, used to reduce friction and heat during metal machine operations, have been found to contain small but significant amounts of nitrosamines, which are known carcinogens. Cutting oils are suspected of causing skin cancer among machinists.

Certain types of wood dust have been thought to cause cancer in various groups of workers. High rates of nasal and sinus cancer have been found among furniture workers in Britain. In Sweden, 45% of recorded nasal sinus cancers occurred among woodworkers (New York Academy of Sciences, 1977).

B. Radiation

The physical properties of radiation make it both potentially useful and potentially harmful. Radiation travels quickly (e.g. radio waves used for communication), carries and delivers energy (e.g. microwave ovens used for heating) and can penetrate certain substances (e.g. medical x-rays used for diagnosis). Each of these characteristics is more common for some types of radiation than for others. The various types of radiation exist as part of the electromagnetic spectrum, so called because radiation consists of electric and magnetic fields.

The Electromagnetic Spectrum



Radiation travels as waves; as one goes from left to right along the electromagnetic spectrum, the wavelength becomes shorter and the energy carried by the radiation increases. The radiation spectrum is divided into two major categories - ionizing and non-ionizing. Ionizing radiation is so called because it creates ions (charged particles such as electrons) when it strikes an atom, thereby creating an electric charge. When ionizing radiation penetrates the body, the energy it carries is great enough to break up the atoms which are the basic units of the body's cells and of all other living substances. Cells whose genetic material is damaged by radiation may become cancerous or, if the genes of the sperm or the ovum (egg cell) are damaged, the damage may be passed on to the individual's child, possibly resulting in a birth defect or miscarriage.

Alpha and beta particles also have properties of ionizing radiation, but are not part of the electromagnetic spectrum. They also travel quickly and carry enough energy to ionize atoms, but since they are solid particles, they have a lesser ability to penetrate the body. Thus, x-rays and gamma rays are capable of penetrating the body and causing damage; alpha and beta particles can only cause damage when they are inhaled or ingested into the body.

Non-ionizing radiation does not carry enough energy to produce ions but it does transmit energy as heat. Infrared (IR), microwave and radiofrequency (RF) radiation all have thermal effects on the body; i.e., they heat the tissue. IR and RF radiation heat the skin; microwaves can penetrate the body and cause more extensive damage. For example, excessive microwave radiation can heat and damage sperm-producing cells in the testicles (which are outside the body because they require a temperature cooler than the rest of the body).

Class Discussion:

Discuss Appendix A, reviewing the different kinds of carcinogens. Chemical carcinogens are grouped by organic and inorganic chemicals; physical carcinogens include both kinds of radiation as well as hypoxia (insufficient oxygen); and biological agents are not included since so few are known. Review the types of cancer caused by the occupational carcinogens listed, the latency (or incubation) period and the occupations with the greatest exposure. Risk ratio will be discussed in Module 5 - the table should be referred to again at that time. Ask students to break into small groups and use the table of carcinogens and the completed Health Hazard Survey forms to determine which carcinogens they are exposed to.

III. Theories of Carcinogenicity

How have certain forms of radiation and certain chemicals been linked to cancer? Historically, studies of cancer in human populations (epidemiology studies) and studies of cancer in animals (laboratory studies) have provided evidence to piece together the puzzle of cancer causation. Over time, researchers have developed theories to explain the process of carcinogenesis based on experimental results.* A significant discovery leading to a hypothesis to explain cancer causation resulted from a laboratory experiment conducted by Berenblum in the 1940s. The results of his experiment showed that some chemicals which do not cause cancer by themselves can, when combined with a low dose of a carcinogen or with a weak acting carcinogen, increase the incidence of tumors in laboratory animals.

Class Exercise:

Use Berenblum's results in Table 1 as a class exercise to present and help students interpret the significance of experimental data results. The table summarizes the results of experiments conducted on laboratory mice to study the interactions between two chemicals, Croton Oil, an irritating but non cancer-causing chemical, and Benzopyrene, a potent carcinogen found in coal tar. Have students interpret the results before discussing the theories proposed by researchers to expiain their significance.

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*For an excellent historical review of chemical carcinogenesis research, refer to Silverstone (Reference #10).

Table 1. Summary of Berenblum's Results

Treatment	Result
Croton Oil alone	No tumors observed
Benzopyrene in low doses alone*	No tumors observed
Benzopyrene in low doses, followed by Croton Oil	10 X increase in tumor incidence

* At low doses in a small population, tumors are often not observed even when a known carcinogen is used.

(Source: Berenblum, 1978)

Berenblum's and subsequent studies suggest that, in some cases, exposure to more than one chemical is necessary for cancer to develop. The initiation-promotion theory of carcinogenesis was hypothesized to explain these results. It appears that at least two stages are involved in chemical carcinogenesis.

Initiation	(the first stage) in which the initiating compound transforms a normal cell into a potential tumor cell;
Promotion	(the next stage) in which a promoting compound stimulates division and replication of the cell, creating a tumor.

(LeServe, p. 39)

Those chemicals that can produce cancer by themselves are called complete carcinogens; others are called incomplete carcinogens. Complete carcinogens stimulate both the initiation and the promotion stages of cancer development. An incomplete carcinogen may be an initiating compound or a promoting compound.

According to the initiation-promotion theory, chemicals classed as weak carcinogens or as non-carcinogens by animal tests may actually be carcinogenic in the workplace or in the community because of the multiple chemical exposures experienced by most individuals. This also may explain why some people get cancer and others, exposed to some of the same substances, do not.

Carcinogens that interact to cause cancer are known as co-carcinogens. When the initiating and promoting compounds are different substances, each compound is considered a co-carcinogen. Another mechanism of interaction between co-carcinogens is the preparative action of a substance. Anything which has the effect of making the target tissue more responsive to the initiating compound may prepare the individual for the first stage of cancer. For example, some insecticides enhance the body's ability to metabolize foreign compounds.

Evidence of Carcinogenic Interaction

Berenblum's study is an example of how scientific research unearths evidence which is then used to develop theories of carcinogenicity. His results provided evidence of a two-stage process of carcinogenesis and of the interactions between co-carcinogens. This evidence was then used to hypothesize the initiation-promotion theory. The exact mechanism whereby carcinogens interact with each other and with the body to cause cancer is often unknown, but the effects of interaction can be seen when there is an increase in cancer among people exposed to combinations of carcinogens. Carcinogens which have additive or synergistic effects can cause cancer on their own but, when combined with another carcinogen, they add to or multiply the effect of that carcinogen.

The synergistic effect, whereby exposure to two substances together has a greater, multiple effect on an individual's chances of getting cancer than exposure to either alone, has been shown in several studies. Cigarette smoking has a synergistic effect with chemical carcinogens and with radiation. Asbestos workers who smoke cigarettes have a 60X greater risk of developing asbestos-related disease than non-smoking asbestos workers. Similarly, young uranium miners who were heavy smokers had a significantly higher frequency of lung cancer than did their non-smoking co-workers. (Saccomanno, et al., 1971).

The increased use of radiation in industry and in the medical profession and the proliferation of chemicals in society may cause the synergistic effects of chemicals and radiation to become an increasingly serious public health problem in the next decade. For example, ultraviolet (UV) radiation reacts with degreasing chemicals such as perchloroethylene and trichloroethylene. When these and other chlorinated hydrocarbon chemicals are exposed to UV radiation, they form phosgene, a highly toxic gas used as a nerve gas in WWI.

No one knows for sure why some people get cancer and others, exposed to the same carcinogen, do not. Several factors affect an individual's risk of developing cancer: the potency of the carcinogen and the level and length of exposure to that carcinogen.

Dose-Response

Once people learn that certain chemicals and kinds of radiation can cause cancer, they want to know how much carcinogen exposure is too much. At present, scientists have no conclusive evidence that there is any safe level of exposure to a carcinogen. There is, however, a relationship between the level of exposure to a carcinogen and the number of people who develop cancer. The higher the dose, the greater the risk of developing cancer. This is called a dose-response relationship. The amount of exposure (dose) is determined by two factors.

DOSE = CONCENTRATION X EXPOSURE TIME

The incidence of cancer is greater among people exposed to high concentrations of a carcinogen or among people exposed to any concentration of a carcinogen for a long period of time.

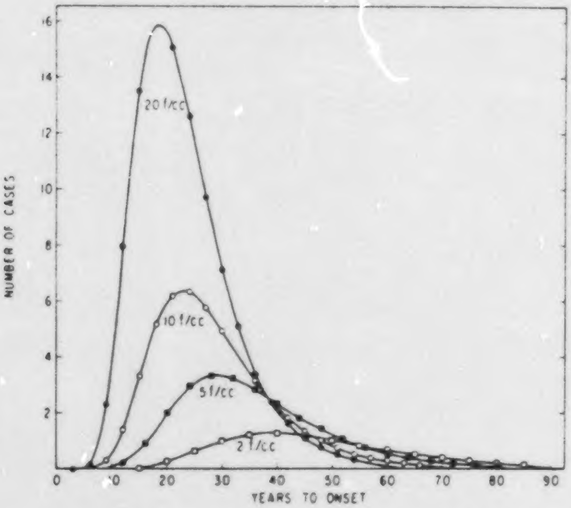
Class Discussion:

- Figures 1-6 can be used to illustrate the concepts discussed below and to help students develop their ability to interpret scientific information presented in graph form. Before explaining each figure, present a sketch of it on a blackboard and ask the class to interpret it.

- Discuss Figure 1.

Enterline's data in Figure 1 illustrate the relationship between the number of cancer cases and the concentration of asbestos in the air (the lowest concentration given is 2 fibers of asbestos per cubic centimeter of air; the highest is 20 fibers per cubic centimeter). It is evident from the diagram that most of the people with cancer were exposed to high concentrations of asbestos.

Figure 1: Dose-Response Relationship between Asbestos Exposure and Respiratory Cancer



Source: Enterline (1976)

While many studies show a dose-response relationship at high levels of exposure, debate about low level exposure continues. Is there a "safe-threshold level" - a level below which there is no increased risk of developing cancer? We know that the lower the carcinogen dose, the less likely the chance of developing cancer; what we do not know is if there is a dose below which one will not get cancer. Inadequate data hamper the ability to resolve debates over a "safe-threshold level."

Very little data are available on the actual exposure levels of workers who have died from occupationally-caused cancer. Most of the available exposure level data are from laboratory animal tests. Since most animal tests are conducted at high exposure levels, almost no information exists about the relationship between low-level exposure and the cancer-causing potential of chemicals and radiation. This makes it very difficult to predict a safe level of exposure for the workplace or the community.

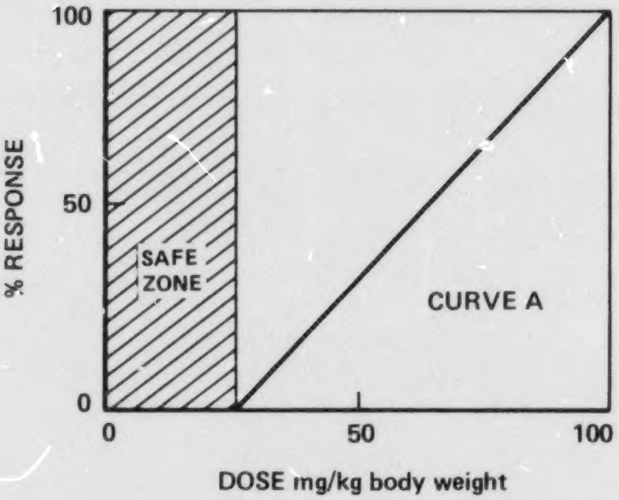
Whether or not there is a safe level of exposure has significant implications for legislative standard setting procedures and for efforts to control carcinogens. Because we have very little accurate data on the exact doses of low level carcinogen exposure, we also have very little data on how people respond to those low exposure levels. For very low doses of most carcinogens, people's response (do they develop cancer?) must be hypothesized.

Class Discussion:

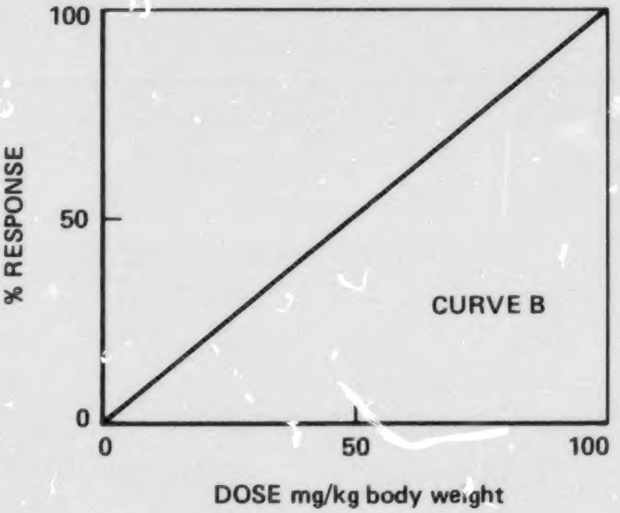
Discuss Curves A and B of Figure 2 before interpreting them as shown under the figures.

Over time and after many court cases, two theories have developed which attempt to describe the cancer risk of low carcinogen exposure.

Figure 2: Hypothetical Extrapolation of Dose-Response Curves



Curve A: Conclusion - a safe threshold level does exist for exposure to a carcinogen. Any exposure at less than this level will produce no excess risk of cancer.



Curve B: Conclusion - there is no safe threshold level of exposure to a carcinogen. Any exposure will result in some increased risk of developing cancer.

What proof do we have for either of the two theories? Some studies of human populations which have examined dose-response relationships for various types of radiation exposure have supported the "no safe threshold level" theory (Curve B in Figure 2).

Class Discussion:

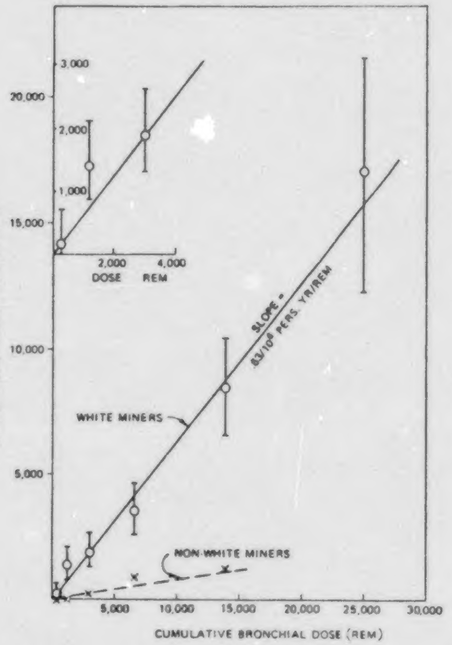
Discuss Figures 3 and 4. The dose-response curve is the line that best fits the plotted points indicated as circles on the graph. Several statistical terms are used in the diagrams. It is only necessary to discuss with the class the basic dose-response relationship shown on the graphs; the following terms are defined for your own information:

1. person-years (PYR) is a term used to describe the total amount of time a group of people is exposed. It is useful since individuals within the group may work for different lengths of time. Each individual is counted only for the time he or she is exposed. For example: 2 people exposed for 2 years each count as (2x2) 4 person-years while 1 person exposed for 5 years counts as (1x5) 5 person-years.

2. error bars, drawn vertically on either side of the plotted points on the graph, indicate the statistical uncertainty of the data i.e., the probability that the data accurately reflect the real results.

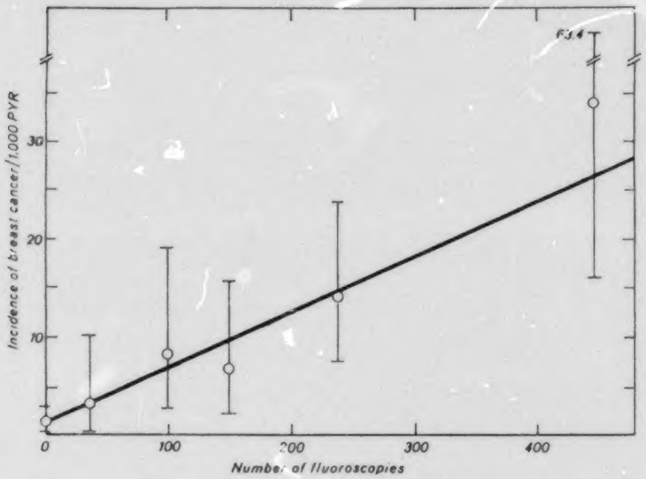
Figures 3 and 4 show an increase in cancer even at small doses. Figure 3 illustrates the relationship between cases of lung cancer among uranium workers exposed to radiation (the doses of radiation are measured in rems). Even at very low doses, shown in the upper left hand corner in larger scale, there is a dose-response relationship. Figure 4 illustrates an increased incidence of breast cancer among patients receiving diagnostic fluoroscopies, a procedure which uses x-rays and a fluoroscope to observe the internal organs of the body. The incidence of breast cancer is directly related to the number of fluoroscopies (i.e. the dose of radiation) even at very low levels of exposure.

Figure 3: Dose-Response Relationship between Radiation Exposure and Lung Cancer among Uranium Miners



Dose-response data for lung cancer in U.S. uranium miners expressed as excess cases per million person years. The assumption is made that 1 working level month equals 5 rem. Error bars for white miners include the 90% range for Poisson statistics. (From data reported in NAS-NRC, 1972.)

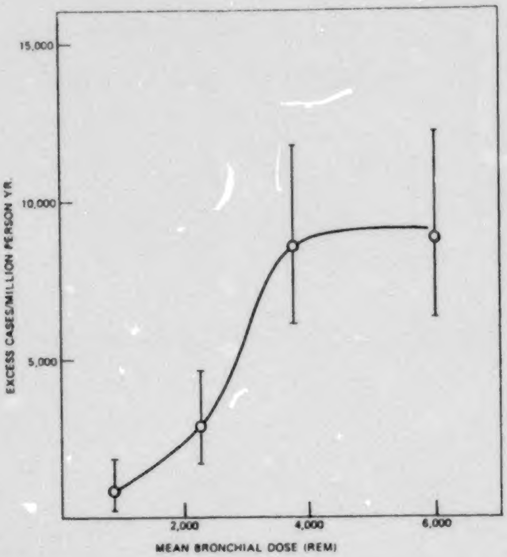
Figure 4: Dose-Response Relationship between Radiation Exposure and Breast Cancer among Patients



Dose-response data for breast cancer among patients receiving diagnostic fluoroscopies expressed as cases per thousand person years. The error bars represent 90% confidence intervals and the solid line is the best fitting weighted least squares regression line. (From NAS-NRC, 1972).

Data from other studies look more like the "safe threshold level" curve. A study of lung cancer in Newfoundland fluorospar miners (Figure 5) shows very few cancer cases at low levels of exposure, a sharp increase in number of cases and then a plateau of cancer cases (responses) above a certain dose. However, the dose-response curve does not extend to zero at the left side of the graph and one cannot assume that an absence of data at low exposure levels implies no problem. Instead, it means only that we have insufficient data to draw a conclusion.

Figure 5: Dose-Response Relationship between Radiation Exposure and Lung Cancer in Fluorospar Miners



Dose-response data for lung cancer in Newfoundland fluorospar miners expressed as excess cases per million person years. The mean bronchial dose is calculated on the basis that miners were exposed at 5 WL and that 1 WLM = 5 rem. Error bars include the 90% range based on Poisson statistics. (From data by de Villiers _et al_, 1969.)

When interpreting data as in the figures above, one should always question the accuracy of the environmental monitoring tests that measure the dose of carcinogens. Sampling instruments or techniques may have _low sensitivity_; i.e., they cannot detect very low levels of a carcinogen or they give inaccurate results at low levels. Sampling methods that give misleading results affect researchers' ability to determine the effects of low level exposure.

Decisions about acceptable exposure levels are sometimes made with insufficient or inaccurate data. They are based instead on an inadequately tested theory. If one believes in the "safe threshold level" theory, then there is a certain level of exposure which is considered "safe;" i.e. any exposure less than that amount should not result in cancer. Theoretically then, the government could set maximum standards of allowable exposure at the threshold level. In reality, determining that threshold level becomes extremely difficult due to the many problems of carcinogen testing: the need for a large number of animals in studies of low-level exposure and the problem of long latency periods between carcinogen exposure and the development of cancer. If one believes that there is no safe level of exposure to a carcinogen, the carcinogen must either be eliminated or controlled in a way that prevents human exposure. Science, politics and economics all play a role in determining what level of exposure (and how much increased cancer) will be acceptable.

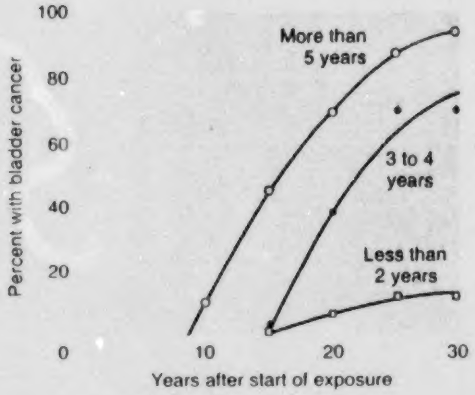
Dose/Latency Period

Several factors determine the length of the latency period; i.e. the amount of time that elapses between carcinogen exposure and the development of cancer.

1. The potency of the carcinogen. Some studies indicate that potent carcinogens such as vinyl chloride and BCME have a shorter latency period than less potent carcinogens.

2. The dose of the carcinogen - the concentration and/or length of exposure. Exposure can be estimated by knowing a person's job classification or the length of time on the job. Figure 6 illustrates the relationship between length of exposure and response. Not only do a greater number of people exposed to 2-naphthylamine for longer than 5 years develop cancer, they also develop cancer sooner than those exposed for less than 5 years.

Figure 6: Bladder Cancer and Length of Exposure to 2-naphthylamine



The time of appearance of bladder cancer in a group of men exposed to 2-naphthylamine. The men are divided into three groups according to total duration of their exposure. [After M.H.C. Williams, "Occupational diseases of the bladder in cancer." In R.W. Raven, ed., Cancer, Vol. III. Butterworth (1958).]

Source: From Cancer: Science and Society by John Cairns. W.H. Freeman and Company. Copyright c 1978.

3. Synergism. Cigarette smoking is thought to shorten the latency period of some occupationally-caused cancers.

Because cancer may not develop for many years after exposure and so may go undetected, there is no solid evidence to prove that any level of carcinogen exposure is a safe level. In other words, we cannot determine a true threshold limit - an exposure level below which an individual has no excess risk of developing cancer; lowering exposures only reduces the risk of developing cancer. "Standards that allow any exposure, then, are really 'risk limitation values'. At best (by implementing such standards), we might reduce the risk by lowering the levels workers may be exposed to" (New York Academy of Sciences, 1977).

IV. Individual Susceptibility

An individual worker's risk of developing cancer is influenced by numerous factors:

1. Characteristics of the carcinogen:

    - Chemical structure or type of radiation. The chemical structure determines whether or not a chemical is absorbed and/or broken down into a more or less toxic form. The type of radiation determines how deeply it can penetrate the body.

    - Physical form (dust, mist, vapor, liquid) and size of substance. The particle size of dusts and the solubility of vapors, gases and liquids determine how easily the carcinogen can enter the body, how easily it can be removed and which part of the body is affected.

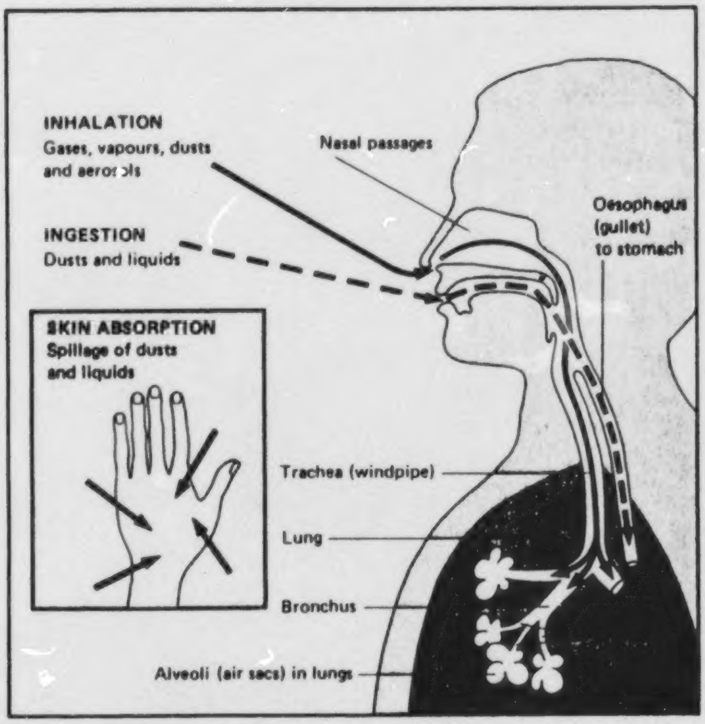
2. Characteristics of the environment determine the dose of exposure to the worker. The frequency and duration of carcinogen exposure are affected by the work process, work schedule, ventilation system, whether the eating area is separate from the work area, etc.

3. Characteristics of the individual
    - Variable individual responses to exposure
    - Tissues in which the carcinogen collects or accumulates
    - The body's ability to eliminate or detoxify the carcinogen

Routes of Entry - Chemicals

Carcinogens only become a health problem when they enter the body. All the factors mentioned above determine whether the carcinogen will be able to enter the body, what route of entry it will take and how the body will respond. There are three major routes of entry into the body: inhalation, ingestion and absorption through the skin. Figure 7 illustrates some chemical pathways into the body.

FIGURE 7: Routes of entry of Chemicals into the Body


INHALATION
Gases, vapours, dusts and aerosols
Nasal passages
INGESTION
Dusts and liquids
Oesophagus (gullet) to stomach
SKIN ABSORPTION
Spillage of dusts and liquids
Trachea (windpipe)
Lung
Bronchus
Alveoli (air sacs) in lungs

Source: LeServe, et al. Chemical Work and Cancer. Permission granted by Van Nostrand Reinhold Publishers (UK).

Inhaling carcinogens is the primary route of carcinogen exposure in most occupations. Dusts, fumes, mists, vapors and gases are usually inhaled directly into the lungs through the trachea and bronchi (see Figure 7). The nose and air passages are lined with cells that produce mucus to trap foreign particles and with tiny hairs called cilia whose waving motion removes the trapped particles. Large particles are more easily removed than very fine dust particles which can enter deep into the lungs. Once in the alveoli, they are not removed. Soluble chemicals such as organic solvents are absorbed directly into the bloodstream from the alveoli.

Ingesting carcinogens in the occupational environment usually occurs when people eat or smoke with contaminated hands or in contaminated work areas. This often happens when washing or eating facilities are inadequate or when workers become careless because there is insufficient education about the potential hazards of the substances in their work area. Inhaled substances may also get into the digestive system when they are pushed up and out of the airway by ciliary action and are then swallowed.

Absorption through the skin or the eyes can cause a broad range of problems. Chemicals can irritate the epidermis and the dermis (the outer two layers of skin) causing toxic effects themselves or making it easier for other toxic chemicals to penetrate the skin. Prolonged exposure causes some people to become sensitized to certain chemicals so that even very small exposures cause a severe allergic reaction.

Routes of Entry - Radiation

Like chemicals, radioactive particles can also be inhaled or ingested. Uranium miners are a group of susceptible workers who are internally exposed to the effects of radiation when they inhale the uranium dust around them. Once inside the body, the particles can cause serious damage to internal organs and tissues; the extent of the damage varies depending on the type of radiation. For example, alpha particles have limited ability to enter the body because they have little penetrating power but, if they are ingested or inhaled, they can cause considerable damage to the more sensitive internal cells.

Radiation can also enter the body in ways that chemicals cannnot. Because it has large amounts of energy, it can penetrate the skin, the body's protective mechanism. Radiation can affect the body in several ways:

1. It can pass through the body causing no damage.
2. It can collide with and kill cells along its path. Damage to a large number of cells can cause organs to stop functioning. Very high

doses of radiation can cause death from radiation sickness (the symptoms vary depending on which organs have been most affected; e.g. if the lining of the digestive tract has been sufficiently damaged, the person may die of internal bleeding and loss of body fluids).

3. It may damage cells along its path, but the body repairs the damage.
4. The nucleus of one or more cells may be damaged but not sufficiently to kill the cells. They then reproduce, passing on mutated genes which may eventually be diagnosed as cancer.

Class Discussion:

Review with students the primary routes of entry and the potential health hazards associated with their own and with the following jobs:

1. For years, printers have used benzene to "wash down" their presses after a day's work. Benzene, in various concentrations, is usually wiped directly onto the press using a bucket and rag. What is the potential health hazard for these workers?

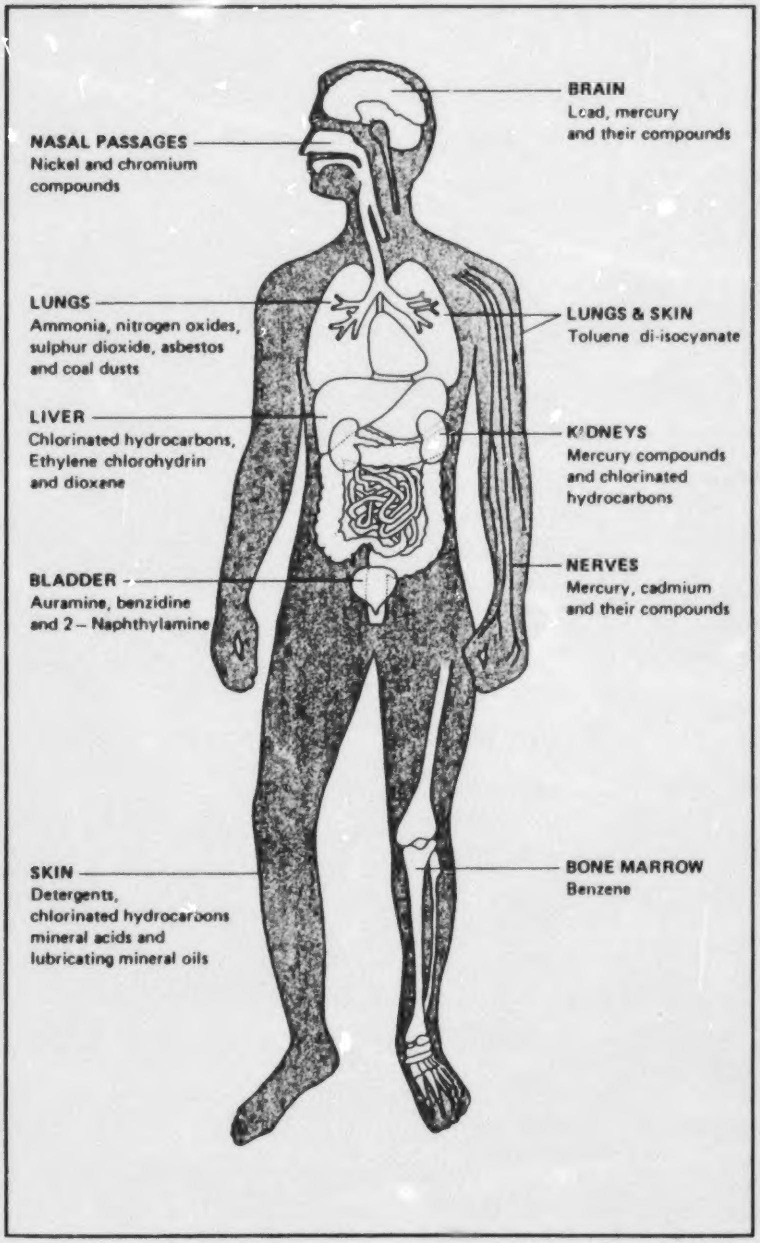
2. In some paper mills, the "color man" mixes powdered dyes to get the right shade for the batch of paper. Some of the brightest and most popular colors, including some oranges and yellows, are benzidene based dyes. What is the potential health hazard and primary route(s) of exposure for these workers?

Tissue Accumulation

Certain types of chemicals have been shown to affect particular target organs. Two occupational examples vividly convey this point.

1. The saying "Mad as a Hatter" refers to the condition found among hatters in the 19th century. At that time, mercury nitrate was used in the fitting process to make hats. Mercury accumulation in the brain led to a form of insanity among hatters.

Figure 8: Organs and tissues which may be affected by particular toxic industrial chemicals


BRAIN
Lead, mercury and their compounds
NASAL PASSAGES
Nickel and chromium compounds
LUNGS
Ammonia, nitrogen oxides, sulphur dioxide, asbestos and coal dusts
LUNGS & SKIN
Toluene di-isocyanate
LIVER
Chlorinated hydrocarbons, Ethylene chlorohydrin and dioxane
KIDNEYS
Mercury compounds and chlorinated hydrocarbons
BLADDER
Auramine, benzidine and 2 – Naphthylamine
NERVES
Mercury, cadmium and their compounds
SKIN
Detergents, chlorinated hydrocarbons mineral acids and lubricating mineral oils
BONE MARROW
Benzene

Source: LeServe, et al. Chemicals, Work and Cancer. Permission granted by Van Nostrand Reinhold Publishers (UK).

2. Several cases of cirrhosis of the liver were reported among dry cleaners. Some physicians concluded that dry cleaners drank more than the average individual. Eventually it was discovered that carbon tetrachloride, an organic solvent used in the dry cleaning process, caused symptoms easily confused with cirrhosis of the liver. Drinking was not the dry cleaners' problem.

Body Defenses

The body has many defense mechanisms against toxic substances. There are numerous examples of how the body reacts to remove foreign substances immediately, before they can be absorbed into the bloodstream. Inhaled substances are removed by sneezing or coughing; ingested toxins may cause vomiting or diarrhea; and substances that irritate the eyes cause tearing and blinking.

Once substances are absorbed into the blood, several organs function to eliminate them from the body. Substances are excreted by the kidney in the urine, they can leave the body in sweat through the skin and those in gaseous form can pass from the blood into the lungs to be breathed out through the mouth or nose.

Some substances are metabolized (broken down) by the liver into other forms that can be more easily excreted. Toxic substances can be broken down to less toxic substances; however, there is also danger that they may be changed to more toxic substances.

All the above defense mechanisms can be damaged by prolonged or very high exposures. Lung tissue can become permanently scarred if foreign substances repeatedly irritate it and the liver and kidneys can be overtaxed by repeated toxic exposures. Damaged cells or organs no longer function efficiently and are incapable of protecting the body, thereby allowing toxic substances to accumulate and exert adverse health effects.

Study Questions

1. How does the media contribute to the public's misconception that everything causes cancer? What could the media do to help correct this misconception?

2. Both the AFL-CIO and the American Petroleum Institute presented arguments to the Supreme Court when OSHA was trying to lower the Benzene standard. The AFL-CIO was supporting a stricter standard and the American Petroleum Institute was supporting the status quo. Which curve in Figure 2 would each party use to defend their position and why?

3. Even though 26 carcinogens are documented as human carcinogens, many are still used by hundreds of thousands of workers without their knowledge of the hazard.

   To help students realize that exposure to occupational carcinogens continues today throughout the American workforce, students should:

   a. Familiarize themselves with the list of known and suspect carcinogens in Appendix A.

   b. Choose one occupation in which workers are sometimes exposed to these carcinogens, and

   c. Interview three people employed in this profession to determine if they do now or ever have worked with the carcinogen.

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Classification of Occupational Carcinogens*

Agents	Affected organ(s)	Incubation period (years)	Risk ratio	Occupation
A. Organic agents				
1. Aromatic hydrocarbons				
Coal soot Coal tar Other products of coal combustion	Lung, larynx, skin, scrotum, urinary bladder	9-23	2-6	Gashouse workers, stokers, and producers; asphalt, coal tar, and pitch workers; coke-oven workers; miners; still cleaners; chimney sweeps
Petroleum Petroleum coke Wax Creosote Anthracene Paraffin Shale Mineral oils	Nasal cavity, larynx, lung, skin, scrotum	12-30	2-4	Contact with lubricating, cooling, paraffin or wax fuel oils, or coke; rubber fillers; retortmen; textile weavers; diesel jet testers
Benzene	Bone marrow (leukemia)	6-14	2-3	Explosives, benzene, or rubber cement workers; distillers; dye users; painters; shoemakers
Auramine Benzidine α-naphthylamine β-naphthylamine Magenta 4-aminodiphenyl 4-nitrodiphenyl	Urinary bladder	13-30	2-90	Dyestuffs manufacturers and users; rubber workers (pressman, filtermen, laborers); textile dyers; paint manufacturers
2. Alkylating agents				
Mustard gas	Larynx, lung trachea, bronchi	10-25	2-36	Mustard gas workers
3. Others				
Isopropyl oil	Nasal cavity	10+	21	Producers
Vinyl chloride	Liver (angiosarcoma), brain	20-30	200 (liver) 4 (brain)	Plastic workers
Bis (chloromethyl) ether Chloromethyl methyl ether	Lung (oat cell carcinoma)	5+	7-45	Chemical workers
B. Inorganic agents				
1. Metals				
Arsenic	Skin, lung, liver	10+	3-8	Miners; smelters; insecticide makers and sprayers; tanners; chemical workers; oil refiners; vintners

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* From: Cole, P. and M. B. Goldman, in *Persons at High Risk of Cancer*. J. F. Fraumeni, Jr., ed. (Academic Press Inc., New York), 1975, pp. 167-184. (The references appearing in the original have been omitted.)

Agents	Affected organ(s)	Incubation period (years)	Risk ratio	Occupation
Chromium	Nasal cavity and sinuses, lung, larynx	15-25	3-40	Producers, processors, and users; acetylene and aniline workers; bleachers; glass, pottery and linoleum workers; battery makers
Iron oxide	Lung, larynx	—	2-5	Iron ore (hematite) miners; metal grinders and polishers; silver finishers; iron foundry workers
Nickel	Nasal sinuses, lung	3-30	5-10 (lung) 100+ (nasal sinuses)	Nickel smelters, mixers, and roasters; electrolysis workers
2. Fibers				
Asbestos	Lung, pleural and peritoneal mesothelioma	4-50	1.5-12	Miners; millers; textile, insulation and shipyard workers
3. Dusts				
Wood	Nasal cavity and sinuses	30-40	—	Woodworkers
Leather	Nasal cavity and sinuses, urinary bladder	40-50	50 (nasal sinuses) 2.5 (bladder)	Leather and shoe workers
C. Physical agents				
1. Nonionizing radiation				
Ultraviolet rays	Skin	varies with skin pigment and texture	—	Farmers; sailors
2. Ionizing radiation				
X-rays	Skin, bone marrow (leukemia)	10-25	3-9	Radiologists; medical personnel
Uranium Radon Radium Mesothorium	Skin, lung, bone, bone marrow (leukemia)	10-15	3-10	Radiologists; miners; radium dial painters; radium chemists
3. Other				
Hypoxia	Bone	—	—	Caisson workers

MODULE 5: TESTING CARCINOGENS

Lesson Objectives:

By the end of this session, students will be able to:

1. Describe the three methods used to test carcinogenicity - epidemiologic studies, animal tests and short term tests.
2. Explain the strengths and weaknesses of each method.

Special Terms:

Ames test
Control population
Epidemiologic study
Morbidity studies
MTD - Maximum Tolerated Dose
Mutation
Proportionate Mortality Rate (PMR)
Prospective/cohort/follow-up study
Retrospective/case-control study
Risk Ratio/Relative Risk
Standardized Mortality Ratio (SMR)
Transformation

Teaching Method:

Lecture
Class Discussion
Debate by students - Study Question # 4 from Module 3

Special Preparation:

Two references are especially helpful in preparing for this module:

1. Mausner and Bahn - Epidemiology, an Introductory Text (See Reference # 11), Chapter 13, "Methods for the Study of Chronic Disease."
2. The United Auto Workers booklet, The Case of the Workplace Killers, (Reference # 5) is a step-by-step explanation of epidemiologic studies for the layperson. It is a useful reference for students and can be ordered in bulk quantities from the UAW.

Review Material:

1. Discuss the Media Watch articles, noting any references to the principles of carcinogenesis discussed in Module 4; e.g. references to co-carcinogens that act in a synergistic manner, potential routes of entry of those carcinogens into the body, etc.

2. Review students' experiences conducting the taped interviews. What did they learn about other people's perceptions of carcinogen exposure and their susceptibility to cancer? Discuss the positive aspects of the interview and any problems students had in communicating with people about health hazards and their effects.

Assignments:

1. Assign selected questions and readings. Distribute the UAW booklet.

2. Assign two students to the Media Watch project.

3. Instruct students to prepare for the second taped group interview:
   - ° develop an outline of a presentation about cancer and carcinogens based on the information they learned in Modules 1-4.
   - ° investigate possible handout materials to distribute to each person in the group; e.g. a good fact sheet on cancer and one on carcinogens in general or one on a specific carcinogen.
   - • determine who they will interview. If possible, working students should interview co-workers and students not currently working should interview workers in a selected industry that uses carcinogens or interview neighbors in a community where there is a local problem with carcinogen contamination.

   In the group interview, the students should present the information they have learned from the modules and readings, Media Watch articles and workplace survey forms. After presenting materials about cancer, workplace and community carcinogens, they should stimulate group discussion by soliciting suggestions from their co-workers about appropriate control measures.

MODULE 5: TESTING CARCINOGENS

I. Introduction

Concurrent with the expansion of radioactive materials and chemicals is a pressing need to develop quick, low cost and effective methods of determining the carcinogenic potential of these agents. To date, approximately 26 chemicals have been strongly associated with cancer in humans. How is the connection between cancer and a particular substance made? This module reviews three methods of testing for carcinogenicity: epidemiologic studies of cancer in people which are done only after workers or community members are exposed, and two kinds of laboratory tests which are done prior to or during human exposure. The strengths and weaknesses of each type of testing should be compared with the urgent need for testing which is so apparent today.

II. Epidemiologic Testing

Epidemiology is the study of death or disease patterns in populations. Important as each individual death may be, seen in isolation it is not useful in identifying the existence of the problem. Only when someone notices that an abnormally large number of people are developing disease or dying do epidemiologic suspicions and detective work come into play.

Over the last two hundred years, numerous cases of carcinogen exposure and cancer have been reported. One of the earliest of these was Percival Potts' observation in 1775 that chimney sweeps were developing scrotal cancer at an unusually high rate. Other examples of significant historical observations of occupationally-caused cancer are listed in Table 1.*

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* The list in Table 1 was compiled from Lehman (1977), Gofman (1981), LeServe et al. (1980) and Wasserman et al. (1982).

Table 1: A History of the Detection of Occupational Cancer

1775 - Percival Potts notices scrotal cancer in chimney sweeps.

1822 - Scrotal cancer among Cornish copper and tin smelters reported.

1870's- Arnstein, an early epidemiologist, records a 40% cancer death rate in Czechoslovakian uranium miners.

1875 - Von Volkman links coal tar exposure with skin cancer among gas plant workers.

1876 - Dr. Joseph Bell shows that workers involved in shale oil extraction and fractionalization had a higher risk of skin cancer.

1895 - Ludwig Rehn associates bladder cancer with dye stuff industry.

1928 - The first case of benzene leukemia is identified in a worker.

1931 - Martland reports excessive rates of bone cancer among radium dial painters.

1939 - Peller reports 20% more lung cancer deaths in uranium miners than in a comparison group.

1950 - Lung and nasal sinus cancer are associated with exposure to nickel and chromium compounds.

1960 - Mesothelioma is found among a group of asbestos-exposed workers.

1964-78-The U.S. Public Health Service and J. Wagoner collect evidence showing a 5-fold increase in lung cancer among U.S. uranium miners.

1971 - Figueroa reports excess lung cancer among BCME workers.

1974 - Polyvinyl chloride exposure is linked to angiosarcoma in rubber workers.

1974-76-Three studies suggest excessive cancer deaths among workers at the nuclear facility in Hanford, Washington; however, these findings are contested by industry and by government.

1975 - Matanowski finds excess skin cancer mortality among hospital radiologists.

1980 - Preliminary studies by Caldwell indicate a significant increase in leukemia among military personnel exposed to nuclear bomb tests in Nevada.

When reviewing the history of the detection of occupational cancer, it is important to highlight the following points:

1. All of the observations listed in Table 1 were made on human populations.
2. The connections between an occupation and cancer were usually made by observant physicians such as Percival Potts who, by chance, happened to see a large number of workers from the same profession.
3. The cancers which have been linked with occupations in this manner have usually been rare. These include mesothelioma (from asbestos exposure), angiosarcoma (from vinyl chloride exposure) and scrotal cancer (from soot in chimneys). Because these cancers were so rare, any increase in the numbers of cases in a small population was more easily recognized and served as a "red flag" to alert the physician.

Class Discussion:

> Given the mobility of today's society, how likely is it that a physician would observe enough people with cancer from the same workplace and so be able to link the disease with occupational exposure to a particular substance? Who would be more likely to make this connection, the small town doctor or the doctor in a major metropolitan area?

Epidemiologists use sophisticated survey and statistical techniques, but anyone can be a lay epidemiologist by being on the lookout for suspiciously high numbers of illness and death.* The following discussion should enable students to understand basic information about epidemiologic studies:

1. When an epidemiologic study might be necessary
2. How a very basic epidemiologic study is designed
3. The weaknesses of using epidemiologic studies to determine carcinogenicity

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* Refer students to the UAW booklet for an excellent discussion of how workers can use epidemiologic techniques at their workplaces.

A. When Should Epidemiologic Studies be Considered?

Epidemiologic studies are usually considered if:

1. A high incidence or mortality rate is noted among a certain group of workers or among members of a community.
2. A population has been exposed to a known carcinogen and scientists want to determine if the rate of disease will be greater over time.

Most epidemiologic studies are conducted after the fact - after the disease and/or deaths have already occurred. They try to determine if there are links between suspected carcinogens and cancer. There are two basic types of epidemiologic studies:

1. Prospective studies, also called cohort or follow-up studies, follow a group (cohort) of people forward in time (prospectively) to determine how many people develop cancer or die. The study population is divided into 2 groups, those exposed to a carcinogen and those not exposed. Morbidity and mortality rates for the two groups are then compared to determine if the exposed group has higher rates than the non-exposed group. If so, such an association might indicate a cause-effect relationship.

2. Retrospective studies, also called case-control studies, are an alternative way of determining if disease or death might be caused by exposure to a particular substance. The epidemiologist compares a group of people who have cancer (cases) with those who do not (controls). He or she then investigates their past history to determine if the two groups have been exposed to different amounts of the suspect substance. If the substance really is a carcinogen, one would expect to see a greater amount of past exposure to the substance in the group with cancer (the group of cases) than in the group without cancer (the control group).

The advantages and disadvantages of each type of study can be summarized as follows (Mausner and Bahn, 1974, Chapter 13):

Retrospective Studies:

Advantages:

- Relatively inexpensive
- Can study rare diseases
- Results can be obtained relatively quickly

Disadvantages:

- Records about past exposure may not be available or people may not know or remember their past exposures
- If individuals must recall their exposures, they may give biased information, i.e., persons with disease may recall their past exposures more readily than those without disease
- It is difficult to select a control group that is similar to the group of cases in every way except the disease

Prospective Studies:

Advantages:

- Less chance of bias because each individual's exposure is known from the start of the study so the investigator does not have to depend on the accuracy of people's memories
- Can observe many disease outcomes: if a substance causes more than one disease, they will all be detected

Disadvantages:

- A long time period is required to see the disease, making it difficult to follow each individual in the group for the entire period
- Expensive
- Prospective studies are generally large-scale undertakings

B. How are Epidemiologic Studies Conducted?

1. Epidemiologic studies are conducted by comparing disease or death rates in the study population with those in the comparison or control

population. Most epidemiologic studies are mortality studies and rely on death certificates.

Class Discussion:

Review the information on a standard death certificate in your state. The following points are important to review in this discussion:

- Death certificates are public documents. Therefore any person can review certificates without special permission.
- Death certificates are usually held by the State or City Department of Health.
- Cause of death is the most important piece of information on a death certificate for an epidemiologist. It can also cause the most problems. Many cancer cases can be lost in the study if the coroner or attending physician has only indicated the immediate cause of death such as "heart attack" or "natural causes" with no other reference to the individual's medical condition.

Epidemiologic morbidity studies compare disease rates between different groups of people. Sources of information for morbidity studies include health insurance records, group health plan data, hospital in-patient and outpatient statistics or workplace or community surveys which specifically focus on signs and symptoms of illness. These types of studies can be just as important as mortality data studies in identifying a new carcinogen.

2. Defining the study population can be a very involved and frustrating part of an epidemiologic study. Since cancer has a very long latency period, the study must cover a sufficiently long period of time to detect abnormal morbidity or mortality patterns. For example, in a

prospective study of occupational cancer, all exposed workers must be followed for a long period of time, a difficult task since people frequently move or are "lost to follow-up" for some other reason. A retrospective study can also pose problems. It is often difficult to locate a sufficiently large group of workers who have a particular type of disease; it is even more difficult to find a good comparison group of individuals who do not have the disease. An equally difficult task can be to accurately compare the two groups' histories to determine if there were different degrees of exposure in the past. Since cancer has such a long latency period, people may not be able to accurately recall whether or not they were exposed to the suspect substance many years ago.

3. The more data about an individual that can be gathered, the more informative the study results will be. The minimum necessary for an occupational epidemiologic study are:
   - Name
   - Race and sex
   - Age at death or onset of disease
   - Cause of death or disease
   - Job history (including job title, date of hire, location and length of time at each job.)

Students should be aware that gathering the data can be either a simple or a difficult procedure depending upon how comprehensive and accessible the appropriate information is. Employment records are a good source of data. Most companies keep employment records on all people who have worked for them. However, if a company's employment records are not available, other sources of information can be used - union membership records, information about pension funds and/or death benefits, insurance carrier records or death notices in the local newspaper.

False conclusions can often be drawn from data if the correct comparisons are not made. For example, in one study of the steel industry in 1971, black steel workers appeared to have a higher lung cancer rate than white steel workers (Lloyd, 1970, 1977). The conclusion that might be drawn from this data is that blacks are more susceptible to lung cancer than whites. Upon closer examination, researchers found that 91% of all black workers versus only 42% of white workers worked around coke ovens. Coke ovens emit several proven carcinogens, including Benzpyrene; 18% of all black coke oven workers were employed full time in topside jobs where the highest carcinogen exposures occur. The industry's discriminatory policies, which placed blacks in the dirtiest, most dangerous jobs, explained the high rate of lung cancer among black steelworkers, not a racial "predisposition" for cancer.

4. Once the information is collected, a death or disease rate is calculated for the study group. Several terms are used to compare the observed morbidity and mortality rates in the study group with those expected, based on rates in a comparison population. For simplicity, this discussion will refer only to mortality rates with the understanding that the discussion also applies to morbidity rates.

A Risk Ratio (or Relative Risk) is defined as:

$$\frac{\text{Mortality rate observed in the exposed study population}}{\text{Mortality rate expected based on rates in an unexposed comparison population}}$$

A risk ratio greater than 1.00 indicates that exposed workers in the occupation being studied have a greater risk of dying from cancer than do unexposed workers. A risk ratio less than 1.00 means a smaller risk of cancer.

Class Discussion:

See the Table of Carcinogens in Module 4 and review with the class the Risk Ratio (Relative Risk) figures for developing cancer when exposed to various occupational carcinogens. Have a representative from each of the small groups which were formed for Module 4's session discuss the meaning of the Relative Risk/Risk Ratio figure for the carcinogens to which group members are exposed (see also Appendix A, pg V-25).

Because it is difficult and expensive to gather data simultaneously on two groups of people (an exposed and an unexposed group of workers), rates from the U.S. population are frequently used instead as estimates of rates in the unexposed group. The rates for each group are then compared in ratio form:

$$\frac{\text{Mortality rate in exposed worker population}}{\text{Mortality rate in U.S. population of same age, sex, race, etc.}}$$

This ratio is called a Standardized Mortality Ratio (SMR) because the rates are standardized (or adjusted) to account for differences in age, sex and race between the exposed worker population and the U.S. population.

In order to calculate the mortality rate for a specific cause, one must know the proportion of people who have died out of the total number of people (both dead and alive), all at risk of death from that cause because of past carcinogen exposure. Exposure may have occurred as long as 20-40 years earlier, making it difficult for the investigator to follow up all the exposed workers to determine whether they have died or are still alive.

A simpler way of evaluating a suspected problem of deaths from cancer is to look at the proportion of deaths due to cancer among total deaths due to all causes in the worker population. This type of study, called a Proportionate Mortality Ratio (PMR) is easier to do than a SMR study because records of death among workers and retirees often are kept by the union or employer for the purpose of insurance or benefits.

A PMR can be calculated for an entire workplace or for a specific department where it is suspected that a higher than normal number of people are dying from cancer. The PMR for that disease in that workplace can then be compared with the PMR for the same disease in the U.S. population:

$$\frac{\text{PMR observed in workplace}}{\text{PMR expected based on U.S. population}}$$

For example, it is known that the ratio of cancer deaths to total deaths in the U.S. population in 1977 was 20.4% (i.e. on average, 20.4 of every 100 deaths in the U.S. were due to cancer). Perhaps in a hypothetical worker population, an investigator finds that 35% of all deaths are due to cancer. A comparison between the hypothetical worker population and the U.S population would give a PMR as follows:

$$\text{PMR} = \frac{\text{35 cancer deaths/ 100 total deaths in workplace}}{\text{20.4 cancer deaths/100 total deaths in U.S.}} = 1.7$$

A ratio greater than "1.0" indicates that there may be a problem due to carcinogen exposure in the worker population.

Although these types of studies are not conclusive and do not identify specific carcinogens, they do give researchers an idea of which occupations may need further study. Once a high risk occupation is identified, an industry-wide study can be implemented to determine the cause. One study was done in the rubber industry where high cancer rates were reported. Analyzing the cancer rates by department helped determine the most common types of cancer and the potential carcinogens in those departments. Appendix A presents data from a rubber industry study which resulted in the identification of a list of carcinogens, including nitrosamines and polycyclic aromatic hydrocarbons. Once these substances were identified, technology was developed to control workplace exposure.

5. Many factors can affect the outcome of an epidemiologic study. These all must be taken into consideration in the initial study design and in the interpretation of the collected data.

    a. High worker turnover: If workers frequently move in and out of a particular job, then each individual's exposure will be less than if a steady group of individuals were exposed continually for 10 - 20 years. With low exposure levels, very large numbers of people must be studied in order to identify weak or moderate carcinogens. Studies of exterminators illustrate this problem.

Exterminators work with a large number of pesticides which have been shown to cause cancer in animals. So far, however, epidemiologic studies have not revealed an excess rate of cancer among this group of workers. Since the turnover rate among exterminators is very high, some epidemiologists believe that the exposure levels have been so low that the number of exterminators studied so far was not large enough to detect a problem.

b. Carcinogen in use for a short time (less than 15 years): If a suspected carcinogenic substance has been marketed only recently, the study may be conducted before the latency period has elapsed, causing the disease rate to appear no greater than normal. Or, workers may use many carcinogens for very short periods of time, making it difficult to prove cause and effect between a specific carcinogen and the development of cancer.

Epidemiologic studies of chemists in research and development departments of chemical companies are often plagued by the second problem described above. In one large chemical plant in West Virginia, for example, a cluster of rare eye cancers was found among the research chemists. However, since the department develops so many chemicals, pinpointing the one which caused the eye cancers has been impossible.

c. Process change: Changing the process through ventilation improvements, building changes, or technology improvements may mean that everyone in the study population was not exposed to the carcinogen even though they all now work in the same department or job category. This difference in exposure can affect study results.

In one study an increased lung cancer rate among chromium workers was identified when those individuals who worked in the old factory were compared with those who worked in the new building. The cancer rate was much higher for those who worked in the old building where ventilation was poor and protective equipment was not routinely used.

d. Unavailable environmental exposure data: In most cases, data on workplace exposure is not available. This makes it impossible to know exactly which workers were exposed to the highest levels of a substance. For example, boilermakers who construct and repair boilers would be most likely to have the highest exposure to asbestos during a boiler repair. However, other tradespeople such as painters or electricians who are working in the same area when the boiler work is going on may also be exposed to high asbestos levels. These workers who would not normally be considered the high exposure group may have a high cancer rate, an unexpected result which could be difficult to explain if this work relationship was not understood.

This example brings up a very important point about comparison groups in epidemiologic studies. Comparisons must be made between exposed workers and non-exposed workers. Since some carcinogens proliferate throughout the entire community, it may be difficult to find a truly unexposed group. The cancer rate of the "control" group which had some exposure may be higher than a truly uncontaminated group. This would make the difference between the exposed and the non-exposed group seem smaller and therefore not important.

e. The healthy worker effect: Occasionally the results of SMR and PMR calculations are less than one. This might lead to the conclusion that work keeps people healthy. In fact, the working population is healthier on the whole than the general population which includes the old and the young, the healthy and the sick, the disabled and the institutionalized. The extent of the difference between the health status of the working population and the general population varies particularly by race and age and requires special attention in an epidemiologic study (McMichael, 1975, 1976).

III. Animal Testing

A. An Overview of Animal Tests

Animal tests are currently the most common method of assessing the cancer-causing potential of chemicals and of various levels of radiation. Some of the advantages of animal studies as compared to epidemiologic studies are that:

1. They are less expensive.
2. The results are more rapid.
3. They involve no loss of human life.

NCI Guidelines for Carcinogen Testing of Small Rodents states that a positive result (the substance causing cancer) in a single species shall be considered evidence of a carcinogenic effect (U.S. DHEW, 1976). Positive results in additional species would substantiate carcinogenicity.

There is, however, considerable debate over how accurately one animal test can predict the human cancer-causing potential of a substance. For example, one animal test of a known carcinogen yielded negative (non-carcinogenic) results but, when tested in a different animal species, the test was postive. This contradictory evidence can be explained because the two species metabolized the chemical in different ways.

Animal species differ from one another and from humans in many ways - their metabolism, lifespan, body size, activities and other environmental exposures. But the similarity in the basic biological processes of all mammals - DNA replication, energy metabolism, cellular, tissue and organ functions, etc. - supports the use of animal studies to test carcinogenicity in humans.

Probably the strongest argument against animal testing is that animals are fed huge doses of a chemical, doses much larger than any person would ingest or inhale in their daily lives. This would not be necessary if a carcinogenic substance caused cancer in every individual animal or person exposed to that substance. But only certain exposed individuals get cancer. The ability of carcinogen tests to detect cancer in the tested animal population depends on:

- the toxicity of the carcinogen
- the lifespan of the test animals
- the number of test animals

Obviously, scientists could more easily detect cancer among the test animal population if the carcinogen was very potent, the animals lived a long time and there was a large population of test animals. Unfortunately for scientific studies, the opposite is usually true: 1) the number of test animals is limited by cost and manageability - most include only 50-100 animals in control and experimental groups, 2) animal lifespans are much shorter than humans and 3) some test substances may be very weak carcinogens. For the first two reasons, it may be difficult to detect even a very toxic carcinogen and detecting a weak carcinogen may be virtually impossible. Only with large doses of the carcinogen can one increase the chances of observing a toxic effect.

Take, for example, the case of a potent carcinogen which causes 200,000 cases of cancer in a population of 200,000,000 people. A population of 1,000 would only produce one case of cancer. Assuming that mice and humans are equally sensitive to the substance, if 50-100 test animals were exposed to the relatively small doses a human might receive, it is possible that none would develop cancer. The population's small size and the fact that these animals don't live the 15-20 years that it often takes people to develop cancer both contribute to the improbability of seeing even one case of cancer. The futility of such an experiment would be even greater for a weak carcinogen.

The purpose of animal studies is to determine whether or not a substance is carcinogenic, independent of the amount of the substance. "The intrinsic ability of a substance to cause cancer is independent of dose level (although the time period between exposure to the carcinogen and the appearance of a tumor, as well as the likelihood of detecting a carcinogenic effect, may be related to the dose level)" (Zoloth, 1980). Studies of many carcinogens do show a dose-response relationship at high exposure levels. Since very little information exists regarding low levels of exposure, some scientists have attempted to extrapolate from high dose levels to low. An example of this type of extrapolation is presented in Table 1.

Table 1: Relationship Between Chemical Contaminants in Diet and Incidence of Cancer

Percent of Chemical in Diet	Percent of Animals with Cancer
1.0	10.0
0.1	1.0
0.01	0.1
0.001	0.01
0.0001	0.001

Source: Rall, 1979

While such a model is useful, these extrapolations cannot be taken as fact in the scientific community. They are based on existing evidence and on scientific assumptions; i.e., that the relationship between the amount of carcinogen exposure and the risk of cancer is proportional at both high and low levels of exposure. And, as discussed in Module 4, there are conflicting theories about the dose-response relationship of carcinogens - especially at low exposure levels.

Another type of extrapolation involves applying the dose-response relationship derived from animal tests to humans; i.e., assuming that human and animal response to carcinogen exposure is similar. To account for the difference in body size between test animals and humans, dose is expressed as amount of carcinogen/kilogram of body weight or as percent of chemical in the diet. The data in Table 2 indicate that a small risk of .001% may mean a large number of deaths for the entire population.

Table 2: Animal Cancer Findings Extrapolated to Population of the United States

Percent of Chemicals in Diet	Percent of Animals with Cancer	Number of Humans with Cancer in a Population of 200,000,000*
1.0	10.0	20,000,000
0.1	1.0	2,000,000
0.01	0.1	200,000
0.001	0.01	20,000
0.0001	0.001	2,000

* These figures represent lifetime risks of developing cancer.
Source: Rall, 1979.

For some types of carcinogen exposure, there is enough epidemiologic evidence to compare human and animal responses. Humans and animals seem to have equal sensitivity to benzidine, chloraphazine and cigarette smoke. In other cases they do not. It appears that humans are, respectively, 10, 50 and 500 times more sensitive than most animal species to aflatoxin B, DES and vinyl chloride (Rall, 1979).

It is also important to note that the risk of developing cancer differs for each substance. Certain risks may be spread throughout the general population, for example, the risk of bladder cancer from consuming saccharin. Or, risks may be concentrated in one population. Workers exposed to "napthalamine" dyes in the textile or paper industries have a higher level of exposure to the carcinogen and therefore experience a greater risk of bladder cancer than the general population.

B. Factors affecting animal studies

1. Choice of species:
   Some species are capable of metabolizing a chemical to its toxic form. Others are not. B-napthalamine is a good example of this. B-napthalamine was confirmed as a human carcinogen in the late 1800's. However, all animal studies using rats and mice were negative (produced no cancer). Finally, someone experimented on dogs. Dogs metabolize B-napthalamine to the carcinogen 2-amino-1-napthol just as humans do. Rats do not metabolize B-napthalamine in this way. Once rats were administered 2-amino -1-napthol they developed cancer similar to that of dogs and humans.
2. Route of administration:
   Animals can be exposed to a test material through several routes - oral, skin absorption, injection and inhalation. The selected route of administration can affect whether a chemical is absorbed into the animal's system, whether it is subsequently distributed throughout the body and whether it has any toxic effects.
3. Dosage:
   As stated before, high doses are a necessity in animal studies. Usually studies are conducted at the maximum tolerated dose (MTD) and 1/2 MTD (Maximum tolerated dose is a dose which produces a moderate inhibition of weight gain (10%) but not a substantial increase in mortality among exposed animals from causes other than cancer).

IV. Short Term Carcinogen Tests

Animal tests are quicker and lower-cost than epidemiologic studies but there is increasing demand to develop even quicker and cheaper methods of testing chemicals. A number of short term tests have been developed for this purpose. Most short term tests are done on cells in culture or on single cell organisms. Scientists look for the substance's ability to cause a mutation in the test organism or transformation in the cell culture.

Mutation refers to a change in the cell's genetic material that is usually damaging to the cell. Chromosomes, genes or the components of DNA can be damaged or realigned. When reproductive cells mutate, the organism's offspring may be affected but the changes may not be apparent for several generations.

Transformation is an indirect process of genetic recombination. In lab tests, bacteria are kept in a nutrient-rich medium called a culture. Sometimes when a chemical is added it reacts with the culture. When this leads to genetic changes in the bacteria, the process is called transformation.

Several studies link cancer and mutation. McCann and Ames found that, of 300 chemical carcinogens, 90% of them caused mutations in bacterial systems (McCann, 1975). Because both chemical mutagens and carcinogens appear to affect the cell by causing changes in the DNA, short term tests for mutations are useful predictors of carcinogenicity. One of the earliest tests of this kind is the Ames test.

In the Ames (or Salmonella-microsome) test, the test chemical and approximately 1 billion Salmonella bacteria are added to a culture of homogenized liver cells. Liver is used because it is the organ where many compounds are metabolized in the body. The bacteria used is a test-strain which requires a mutation to occur in order to reproduce in large numbers. By observing the rate at which the bacteria reproduces, one can tell if the chemical caused the bacteria to mutate. A dose-response relationship can be determined by varying the amount of chemical used and counting the bacterial colonies. This test, however, is not accurate for all chemical carcinogens. Compounds that are metabolized at sites other than the liver, for example, will not show up in the results (Legator, 1974).

Because each test has its limitations, the current trend is to use several short term tests to determine if a chemical affects the cell's genetic material. Cytogenetic tests look directly at the chromosomes themselves to determine if any changes have occurred. Chromosomal aberration and Sister Chromatid Exchange (SCE) are two types of tests which are frequently conducted to identify chromosomal damage.

In chromosomal aberration studies, scientists count the frequency of broken, double, or other abnormal forms of chromosomes in an exposed cell population. This number is then compared with the number of aberrations in unexposed cell populations.

In Sister Chromatid Exchange Studies, cells are stained, exposed and allowed to replicate. After a certain number of cell divisions, the number of exchanges between sister chromatids are then counted and compared with the number of sister chromatid exchanges in unexposed cell populations.

These types of short term tests can be used in the laboratory to test the potential mutagenic effects of chemicals. They are also used in the field as part of medical screening tests to study the chemical and radiation exposure of workers or of the general population. In fact, numerous studies using cytogenetic measurements have been conducted to detect the effects of ionizing radiation exposures on human populations. Tested populations include survivors of the atomic bomb in Hiroshima and Nagasaki, uranium miners and nuclear dockyard workers. These studies have been less frequently applied to chemical exposures in the workplace.

Although there is agreement that chromosomal changes are undesirable, the primary problem with cytogenetic tests is that they cannot predict specific health effects in an individual. As more data is collected, however, these predictions may be feasible (Bloom, 1981). Another limitation is that some chemicals produce positive results in animal cancer tests but not in short term tests. Short term tests measure a chemical's ability to affect DNA. Apparently, not all carcinogens have a direct interaction with DNA. So, while short term tests are very helpful and their use could be greatly expanded, they cannot be relied upon as the only method of carcinogen testing.

STUDY QUESTIONS

1. What effect on the final results of an epidemiologic study would there be if several cancer victims were not found and therefore not recorded?

2. Should short term tests and animal tests be used to predict cancer in humans? List the advantages and disadvantages of their use and keep the list until the session on setting legislative policy.

3. If you wanted to do a mortality study at your workplace, what sources would you use to get the necessary information? Do any of these sources include job histories of the deceased? If not, how would you obtain this necessary information?

4. Epidemiologic studies can be very useful tools when assessing an occupational cancer problem. They are much more difficult to use successfully on environmental or community health problems. List the factors in both the occupational and community settings that contribute to this.

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Appendix A

Type of Cancer	Risk Ratio*	Work Areas of Highest Risk
Bladder Cancer	1.5 to 2.5	o Compounding o Chemical Plant o Mixing o Tire Building o Warehouse/Shipping and Receiving o Milling o Reclaim o Cement Mixing o Plastics o Calendering
Skin Cancer	6.5	o Tire Assembly
Brain Cancer	4.1	o Tire Assembly
Lymphatic Cancer and Leukemia	2.5 to 5	o Tire Building o Calendering o Tire Curing o Elevators o Tubes o Rubber Fabrics o General Service o Compounding o Mixing o Finishing, Repair, and Inspection o Cement Mixing o Tire Painting o Plystock Handling o Synthetic Plant o Tread Extrusion and Cementing o Janitoring and Trucking

Type of Cancer	Risk Ratio*	Work Areas of Highest Risk
Stomach Cancer	2 to 2.3	o Synthetic Plant
		o Compounding
		o Mixing
		o Mill-Mixing
		o Milling
		o Testing Laboratories
		o Tread Extrusion and Cementing
		o Receiving/Shipping
		o Calendering
		o Tube and Flab Building
		o "Green" Tire Preparation
Intestinal Cancer	2 to 2.3	o Milling
		o Rubber Making
		o Solid Tires/Tracks
		o Tread Extrusion and Cementing
		o Maintenance/General Service
		o Special Products
Pancreatic Cancer	2.5 to 3	o Tire Curing
		o Elevators
Lung Cancer	1.4 to 2.3	o Synthetic Latex
		o Receiving/Shipping
		o Cement Mixing
		o Compounding
		o Mill-Mixing
		o Tread Extrusion and Cementing
		o Tire Curing
		o Fuel Cells/Deicing
		o Tire Molds
		o Reclaim

Type of Cancer	Risk Ratio*	Work Areas of Highest Risk
Prostate Cancer	1.6 to 3.5	o Calendering o Compounding o Mixing o Janitoring and Trucking o Cement Mixing o Maintenance/General Service o Final Finish o Material Conservation

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* In this small population of workers, normal risk is 1.0 and increased risk is greater than 1.0

Source: Cancer in the Rubber Industry: The Risks and What You Can Do About Them. U.S. Dept. of Labor, Occupational Safety and Health Administration. May, 1980, OSHA 3068.

MODULE 6: CARCINOGENS IN THE WORKPLACE: HAZARD INVESTIGATION AND CONTROL

Lesson Objectives:

By the end of this session, students will be able to:

1. Describe worker and management responsibilities for controlling workplace carcinogen exposure.
2. Discuss the advantages and disadvantages of both Union Health and Safety Committees and Union-Management Health and Safety Committees.
3. Describe the steps necessary to the establishment of a workplace carcinogen control program (i.e. establishing a Health and Safety Committee, investigating carcinogens and establishing a carcinogen control program).
4. Describe the steps involved in investigating workplace substances for carcinogenicity.
5. Explain the major methods of controlling workplace carcinogen exposure.

Special Terms:

Administrative controls
Enclosure
Engineering controls
General Ventilation-Dilution
Generic Chemical Name
Health Hazard Evaluation (HHE)
Industrial Hygiene
Isolation
Local Exhaust Ventilation
Material Safety Data Sheet (MSDS)
Personal Protective Equipment (PPE)
Substitution
Trade Name
Walkthrough Investigation

Teaching Method:

Lecture
Class Discussion
Guest Presentation

Special Preparation:

1. Prepare a list of local coalition groups that students can contact to complete Assignment #6 below.

2. Select handout materials. See samples attached at end of Module as Appendices and fact sheets ordered in advance (p. xi).

3. Contact a representative from an active local union health and safety committee to discuss both the successes and problems of the committee's work. (See Class Discussion page VI-7.)

Review Material:

1. Review Module 5 study questions.

2. Collect and review the outlines developed for use in the second taped interview assignment.

3. Discuss the Media Watch articles.

Assignments:

For all students:

1. Assign selected readings. Assignment nos. 3-6 below replace the study questions for this module.

2. Assign two students to the Media Watch project.

> Assignments nos. 3 - 6 will take some time. The due date will be determined by the length of the course. Ideally, this information will be collected over the period of several weeks, then will be presented as part of a final project after Module 9 has been completed. See page VIII-3 for a discussion of the final project.

Workplace Assignment (for working students)

3. Investigate the potential carcinogenicity of workplace substances. Obtain the generic name of chemical substances and request MSDS's from the employer or the manufacturer. (See Appendix A.) Students should be warned that it is not always easy to obtain MSDS's. They should list any problem they have obtaining the requested information and should not try if they fear retaliation from an unsupportive supervisor.

4. Investigate union health and safety activities:
   - Health and safety contract language - get a copy
   - Records of past grievances about health hazards
   - Education about health and safety issues - newsletter articles, stewards training sessions, health brochures, fact sheets, etc.

5. List the current control measures used in your workplace - administrative, engineering, PPE and work practices.

Alternative Assignment (for students not currently working)

6. Investigate local coalition activities between worker groups and community or environmental groups to control carcinogens. Describe the specific carcinogen exposure problem, the activities taken and the process whereby those various groups combined their efforts. Discuss the successes and the problems of forming coalitions between groups that have both similar and different interests.

MODULE 6 - CARCINOGENS IN THE WORKPLACE: HAZARD INVESTIGATION AND CONTROL

I. Introduction

The goals of investigating workplace carcinogens are to identify where they are used, which workers are exposed, and then to develop methods of eliminating the carcinogen from the workplace or of eliminating exposure to workers. Exposure standards established by OSHA (the Occupational Safety and Health Administration, discussed in Module 8) set values for some carcinogens which may not be exceeded in the workplace. For example, the standard for asbestos is 2 asbestos fibers per cubic centimeter (2 f/cc) of air. However, there is no known safe level of carcinogen exposure. If a carcinogen cannot be eliminated from the workplace, controls must be implemented to maintain the lowest feasible levels of worker exposure.

II. The Roles of Management and Labor

Investigating and controlling exposure to occupational carcinogens must include both the individual and cooperative efforts of workers and of management. Both groups have specific responsibilities, but successful health and safety programs are only possible through joint decision-making. Employers are ultimately responsible for providing a workplace "free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees." (Occupational Safety and Health Act of 1970). However, without pressure from workers, many employers fail to fulfill their obligation. Those who do implement health and safety programs often do so without involving the workers for whom the programs are designed.

A. Management Responsibility

Effective control of workplace carcinogen exposure is inseparable from the organization and implementation of a comprehensive safety and health program. Since work processes are constantly changing, hazard investigation and control must be an ongoing program. Management's role in a cancer control program includes certain responsibilities.

1. Knowing the potential hazards of all chemicals used in the shop, and requesting Material Safety Data Sheets (MSDS's) for each substance from the manufacturer.
2. Working closely with the Purchasing Department so that all new chemicals are reviewed for toxicity before being introduced into the production process.
3. Establishing an inventory and labelling system in order to keep close control over the use of toxic chemicals and radioactive substances.
4. Providing a list of chemicals and their known health effects for each department, for company health care providers and for health care providers at local hospitals and clinics.
5. Conducting industrial hygiene monitoring in those areas where workers are exposed to toxic materials, and making the results available to those workers.
6. Developing both short and long term programs for controlling exposures to toxic materials.
7. Conducting training programs for supervisors and hourly workers on the potential hazards of the job, proper protective measures and plans for hazard abatement.*
8. Providing confidential health care services for the early detection and treatment of potential work-related health problems.

B. Worker Responsibility

Effective management health and safety programs should include the active participation of union representatives or employees who are elected by their co-workers. Unfortunately, management officials too often exhibit an apparent lack of interest in workers' health and safety or in providing a way to integrate workers into the health and safety program. In those cases, worker can gather information themselves and use it to gain safer work conditions.

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* The importance of training in a successful health and safety program cannot be overemphasized. Since supervisors are often given the responsibility of enforcing health and safety policy, they must be well trained and convinced of the seriousness of their responsibility.

The following steps (described in more detail later in the module) are not always easy but have been used successfully by various groups of workers.

1. Form a health and safety committee which represents both sexes, different races and different departments in the workplace.
2. Conduct periodic worker surveys, using questionnaires to identify the names of chemicals being used, the sources of radiation exposure and the number of exposed workers.
3. Conduct periodic walkthrough inspections of the plant to determine health hazards. Observing operations and talking to other workers can be very revealing.*
4. Know what people are working with. After compiling a list of chemicals by doing worker questionnaire surveys and workplace walkthrough inspections, investigate the potential health hazards of those chemicals. Several ways of doing so are discussed in Section III of this module.

For effective worker involvement in health and safety issues, people must be willing to speak up about the problems they observe. However, fear of harassment or of being fired prevents some workers from asking for workplace improvements, especially those who do not speak English, are undocumented workers or are non-unionized. Although OSHA and the National Labor Relations Board (NLRB) provide protection for workers, many who fear reprisal are either unaware of the laws or cannot afford to be out of work during the often lengthy time period in which the court system is reviewing their case.

Unionized workers have more protection from being fired. However, 75% of the work force is not unionized. Organizing around health and safety issues may be difficult without a union and may depend more heavily on management's cooperation. One example of successful organizing outside a union structure is that of the National Association of Working Women, which works with clerical workers, a group traditionally unorganized. Workplace hazards, particularly office automation and the health effects of using VDTs (video display terminals) have become successful organizing issues.

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* For a guide to hazard identification and evaluation, see Chapter 2 of Proctor and Hughes, Reference # 5.

Some employers consider any type of workplace organizing a threat. In those cases, individuals sometimes organize union representation simultaneously with health and safety organizing to protect against possible repercussions from the employer.

Unionized workers with collective bargaining rights have an existing structure through which to implement the above steps. Unions can be active around health and safety issues at the local and national levels. Some unions have a long, successful history of fighting for health and safety improvements.

Class Discussion:

- Introduce the guest speaker, a representative from an active local union Health and Safety Committee.
- Students who are union members can share specific examples of health and safety problems in which their union has become involved. Discuss the barriers that inhibit management or co-worker support of health and safety organizing.

If the following points have not been adequately covered in the class discussion, summarize the ways unionized workers can organize around the health and safety issue, using the points below as examples.

a. At the national level, unions can allocate resources for health and safety activities. A national staff can provide:
   - Lobbying power in Washington
   - Training sessions and resource materials for the union locals, including guidelines for negotiating contract language
   - Media publicity to increase public awareness of workplace health hazards
   - Research efforts by the union's technical staff or in conjunction with research institutions

b. At the local level, workers can:
  - Establish ties with the national office and take advantage of their resources
  - Establish a union health and safety committee that has bargaining power with management

c. At both the national and local levels, unions can join coalitions to work for long-term changes in working conditions.

d. National and local unions can establish contract language that guarantees the ability of Health and Safety Committees to effectively represent their members' concerns. The United Auto Workers (UAW) successfully negotiated important contract language with Chrysler, Ford and General Motors in their 1973 and 1976 contract talks. Important components of those contracts included the right:
  - To create management-union safety committees at the national and local levels
  - To appoint full-time health and safety representatives in plants with at least 1,000 workers with wages paid by the company
  - Of safety representatives to inspect any factory at any time
  - To authorize local strikes over health and safety problems
  - To obtain information about hazardous substances, medical test results and air quality testing.

III. Setting up a Carcinogen Control Program in the Workplace

A. Health and Safety Committees

Whether organizing a health and safety program within or outside a union structure, the first step is to form a Health and Safety Committee. The Committee can recommend that carcinogen control measures be implemented but those recommendations are useless unless the group has some authority. Some unions form their own Health and Safety Committees, others form joint union-management committees. In either case, workers should be able to meet separately to discuss issues themselves and then meet with management to discuss methods of implementing necessary changes.

Union Health & Safety Committees can discuss proposals for negotiating specific contract language. In addition, the unions can use the grievance procedure for resolving complaints about health and safety problems that fail to meet specific contract provisions or that are not in compliance with the more general 1970 OSHA Act which mandates employer responsibility to provide a safe and healthful work environment.

Health and Safety Committee members should also meet with management representatives. Their proposals can be effective if formulated after sufficient input from workers, if the management and worker representatives have equitable division of power and if the company cooperates by providing the necessary resources.

B. Investigating Carcinogen Exposure

The goals of a program to investigate carcinogen exposure are to identify the carcinogens present in the workplace and to determine how many workers are exposed to those carcinogens. Several steps are involved in this process.

1. Investigating workplace substances:

The Health and Safety Committee must know what people work with. Knowledge of chemicals' generic names rather than just their trade names is essential to any preventive effort. The generic or chemical name is the formal name by which the scientific community refers to a chemical. A trade name is the manufacturer's name. Trade names will almost invariably differ from manufacturer to manufacturer. Without the generic name, workers will not be able to determine the potential health hazards of a chemical. There are several ways to obtain the names of chemicals in a product.

a. Ask management for Material Safety Data Sheets on each product (See Appendix A). MSDS's should be provided to the employer by the manufacturer selling the product. In many states with Right-to-Know regulations (see Module 8), the employer must respond to employee requests for copies of any MSDS he or she has available but is not necessarily responsible if the manufacturer does not send one.

CAL/OSHA has gone a step further by compiling a list of substances for which the employer must make MSDS's available (if not currently on file, the employer must obtain one). If workers feel uncomfortable requesting information from their employer, the alternatives are to:

- b. Read the label on the product and write to the manufacturer themselves for the MSDS and for any other available information.
- c. Research chemical names in resource books (e.g., Lewis, 1979; Sax, 1979).
- d. Become familiar with information resources offered through OSHA and NIOSH (the National Institute for Occupational Safety and Health, a research aim of OSHA) and through the State Department of Labor.

The Committee will probably not begin its investigative work with an exhaustive list of workplace substances. Identifying the work processes that use carcinogenic chemicals or ionizing radiation is an on-going process. As human or suspect animal carcinogens are identified, controlling worker exposure to those substances should be a top priority. Worker and workplace surveys are useful tools for 1) gathering information (the identity of substances that the Committee members may be unaware of, the number of workers exposed to those substances and the way in which they are used), 2) raising co-workers' awareness of potential workplace hazards, and 3) organizing around carcinogen control.

2. Worker surveys

Confidential questionnaire surveys can be used either to get a comprehensive view of workplace hazards (useful for a newly formed health and safety committee) or to investigate the extent of exposure to a specific carcinogen. Worker complaints are often the first indication of a health hazard that may have longer-term effects. Questionnaires often include the following catergories:

- a. Work environment questions ask about chemical and radiation use, equipment, lighting, ventilation and work processes.

b. Work schedule questions ask about breaks, length of time the worker spends working with different substances or work processes and, if appropriate, what shift the person works.

c. A health section attempts to determine health problems that might be related to the work environment or the work schedule. Chronic, long-term health effects such as cancer are usually difficult to ascertain by questionnaire reporting since symptoms do not appear immediately. This is especially true for radiation since neither exposure nor its immediate effects are detectable. However, acute health problems caused by chemical exposure are often detectable; e.g., tearing eyes, respiratory problems, severe headaches, frequent drowsiness, etc. and may be indicators of potentially serious long-term health effects.

3. Workplace surveys

Investigators survey the workplace by conducting walkthrough inspections. A walkthrough is simply that - designated health and safety committee members walk through a specific department, observe the work processes and working conditions, note health and safety problems on a hazard checklist and conduct industrial hygiene monitoring tests if possible. The Committee's goal might be either to get an overview of an area's problems or to investigate a specific carcinogen's use; for example, the names of all chemicals used in the area or the use and proper labelling of radiation sources. Management cooperation is necessary to give the investigators free access to the work area and to enable them to question the employees, the people most familiar with the hazards in their area.

A well-designed hazard checklist is an essential component of a successful walkthrough investigation. The Committee may want to use a general checklist such as that included with Module 1 if this is an initial overview investigation. Or, committee members may want to develop another checklist specific to the area they will survey based on information gathered from employees in that area and from a review of scientific literature.

A walkthrough investigation has limitations: management cooperation is necessary, the investigators have only a certain amount of time to observe working conditions, and it is impossible to talk with all workers in the area about their perceived problems. However, by combining a work questionnaire survey with the walkthrough, the Committee will be able to gather extensive data for use as a basis for establishing a carcinogen control program.

4. Documentation

The Health and Safety Committee must carefully document and file all the above information for later use. A filing system should include specific files for the information gathered from worker and workplace surveys and about specific workplace substances. In addition, the following records provide useful information if available:

- Records of worker exposure include summaries of medical exams or lab tests and results of workplace industrial hygiene monitoring tests (e.g., radiation badge readings)
- Records of workplace illnesses and injuries - the OSHA Form #200, the "Log and Summary of Occupational Injuries and Illness," will not indicate cancer but does give a brief overview of the extent of health and safety problems at a workplace (see Appendix B, the California form which is identical to the federal OSHA Form 200).
- Records of any previous OSHA inspections

The importance of careful documentation cannot be minimized. If the Committee documents all instances of hazardous conditions or health problems, those notes can later be used to negotiate improved work conditions.

5. Using government agencies

In the case of hazardous work conditions that cannot be improved by worker-management negotiations (there is no union or health and safety committee; they don't have sufficient power or the employer is uncooperative), workers can request an OSHA inspection. OSHA offices are often insufficiently staffed so that responses may take some time. If it becomes necessary to request an OSHA inspection, records kept by individuals or by the union health and safety committee are invaluable assets. OSHA may respond more quickly if there is sufficient documentation of a hazardous situation. A summary of those records should be sent with the request for an inspection and should be given to a well-prepared worker representative who is legally allowed to accompany the OSHA inspector to identify specific problems.

NIOSH, the research arm of OSHA, has no regulatory power but its recommendations can influence OSHA actions. It can play a valuable role by investigating health problems that workers have documented for which there is no known cause. After conducting a Health Hazard Evaluation, NIOSH makes recommendations which can then be used by workers to negotiate necessary workplace changes or to push for better legislation.

C. Controlling Carcinogens

A carcinogen control program should include both a worker education and training component and the implementation of specific control measures.

1. Education and training

Management is ultimately responsible for providing employee training in the safe use of workplace substances. The Health and Safety Committee should work with management to insure adequate employee programs and should also implement its own programs. There are two important levels of education and training:

a. Mass education efforts should reach all employees via newsletter articles, mailings, posted fliers and meetings. In addition to general health and safety education, workers should be notified of Committee survey results and of actions taken to alleviate problems. Individual workers can also be educated about the importance of their own record-keeping: documenting the substances with which they work, health problems they experience, etc. Personal records can be useful in case of an immediate problem or if a problem surfaces in the future; e.g., if the employee is ever involved in a worker's compensation case.

b. Special sessions are needed for more extensive training; shop stewards, business representatives and health and safety committee members all need regular training sessions on hazard identification and control. Health and safety training can be incorporated into existing stewards training sessions, committee or union meetings, etc. It is essential that employees be given paid release time from work for periodic education meetings and for special training sessions.

2. Control measures*

Hazard control measures can be extremely complicated. Administrative and Engineering changes and the use of Personal Protective Equipment (PPE) are all different forms of hazard control.

a. Administrative controls are process or personnel changes instituted by management to lower worker exposure.

- o Elimination - Eliminating the toxic substance entirely will prevent not only occupational exposure but will also preclude other long range problems such as waste removal and pollution control. Elimination is easier if the hazard is discovered early, before it is widely used. However, when a product is in widespread use, e.g. vinyl chloride or asbestos, elimination is often impossible because of economic, social and political factors.

- o Substitution - Substitution involves replacing the carcinogen with a non-carcinogen. It is essential that the toxicity of the substitute is known. Too often, substitute chemicals have been introduced without proper testing and have been proven to be carcinogens themselves 20 or 30 years after many people have been exposed.

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* Distribute the fact sheets ordered at the beginning of the class: "Respirator Protection" and "Design of Local Exhaust Ventilation." (See the list of references in the section entitled "Structure of the Curriculum," p.xi preceding the modules.)

- Isolation - In some places, a special area can be identified where the carcinogen is used. Access to that area must be limited to a select group of people who have been adequately trained about the potential hazards of the carcinogen and about safe handling procedures in these areas. Warning signs must be posted and records of the exposed employees and their exposure levels must be kept for at least 30 years.

- Worker Rotation - Some management officials have attempted to lower the individual worker's exposure by instituting a policy which limits the total time one individual spends doing a high risk job, and instead requires rotating several people through the job during the day. Although worker rotation does lower the overall exposure of the individual who originally worked full-time at that job, it in turn increases the total number of exposed people. Since there is currently no known safe exposure level to a carcinogen, worker rotation is not a recommended method to control carcinogen exposure.

b. Engineering Controls

- Enclosure - When carcinogens must be utilized, some operations can be partially or fully enclosed to eliminate worker exposure. Mechanical handling devices such as glove boxes and robots or computerized operations are often used to prevent employee exposure.

- All machines and operations must be serviced occasionally. Maintenance workers often come in contact with high concentrations of toxic materials during maintenance and clean-up operations. Special attention should be paid to protecting this group of workers when designing a hazard control program.

- Ventilation - There are two major categories of ventilation systems: dilution and local exhaust systems. Local exhaust ventilation is the only acceptable form of ventilation for carcinogens. Since there is no known safe exposure level to a carcinogen, simply circulating fresh air throughout the work area to dilute the concentration of the carcinogen in the air will not provide adequate protection.

Local exhaust systems are a series of hoods, fans, ducts, and air cleaning devices which all work to remove the contaminants away from the worker's breathing zone.

There 3 major types of local exhaust systems. The types of operations for which they are most effective are described below.

1. Canopy hoods - used for control of hot processes and for operations which release sudden surges of hot gases and vapors. Should not be used where people must work directly above the operations because the hood draws contaminated air upward through the worker's breathing zone. Good for kilns, furnaces.
2. Slotted hoods - used to provide uniform exhaust air from a work area of definite length. Good for degreasing tanks, laboratory work tables, etc.
3. Flexible ducts - used for operations requiring workers to move throughout the work area. Good for welding, grinding, sanding, etc.

Ventilation system designers must pay strict attention to the location and quality of exhaust air by following certain basic design principles. Carcinogens should not be vented directly to the outside environment to avoid exposing the surrounding community amd contaminated air should be vented away from the building's air intake system to avoid recirculating the contaminants through the workplace via the ventilation system.

Monitoring the levels of environmental chemicals or radiation tests the effectiveness of engineering controls and is an essential part of any carcinogen control program. Monitoring of both the general workplace environment and individual exposure is important in order to get a true picture of carcinogen exposure. As awareness about the hazards of various carcinogens increases, the technology of environmental monitoring is improving considerably. Today, for many chemical carcinogen and radiation sources, continuous monitoring equipment is available. This equipment not only provides a permanent record of employee exposure for future research or compensation cases, but also can be designed to set off an alarm at a certain level, warning workers in the area of a breakdown or spill, and indicating emergency precautions to be taken.

Monitoring equipment must be designed for the particular contaminant of concern. Gases and vapors are sampled one way and dust and mists are sampled an entirely different way. Different types of equipment must be used for different types of radiation (beta, gamma, alpha, and x-rays). Personal monitoring is especially important for radiation workers. This can be done through radiation film badges which measure the individual's absorbed dose of radiation.

Whatever the type of monitoring equipment, it must be calibrated regularly to be reliable. Under the Federal OSHA law, workers have the right to find out what their exposure levels are on the job. Area samples taken in the immediate vicinity of an individual, and any personal sampling data must be available to a worker or to a designated representative upon request.

Monitoring data as well as any medical testing information should be maintained for a worker's lifetime. This will provide a permanent record for use by workers and employers in the future.

c. Personal protective equipment

When a hazard cannot, at the present time, be controlled by engineering or administrative measures, personal protective equipment must be used. Protective equipment is the last choice for exposure control and should not be used as a permanent solution to a problem.

Probably the greatest problem associated with PPE is choosing the right equipment for the job. The hazard's route of entry into the body determines what type of PPE is necessary. Respirators should be used for inhalation exposure. Impermeable clothing, gloves and goggles are necessary to prevent eye injury and skin absorption. Too often, PPE is improperly used and maintained.

Class Discussion:

Since personal protective equipment is all too often used as the final means of controlling a hazard, discuss with students the inherent problems in using PPE. The discussion should cover the physical inconvenience of using respirators and protective clothing.

1. PPE can be extremely uncomfortable, especially on hot or confined space jobs. Workers often

either suffer discomfort or avoid using the equipment, thereby making it worthless.

2. PPE can place an excess strain on an individual's body.
3. PPE can interfere with job performance if continuous communication is necessary.
4. Proper equipment is often not used; e.g. different types of respirators must be used to protect against different substances.
5. PPE only protects if it fits correctly. Individuals vary tremendously so a perfect fit is often difficult to achieve. Women in traditionally male occupations are often encumbered with protective clothing that is too large and men with beards cannot get a tight seal on a respirator.
6. PPE is often improperly used and maintained. Training about the hazard and about the proper use and maintenance of the PPE is an essential component of the program.

Review with students the need for proper training and maintenance of protective equipment.

d. Personal hygiene/work practices

Any work with carcinogens must involve good personal hygiene. Smoking and eating must be prohibited in the work area and wash-up facilities must be provided on site. Good housekeeping is also another important way of decreasing levels of chemicals in the work area.

Eating or smoking away from the contaminated area is difficult at some worksites where there are no lunchrooms or where workers are not given any time off for lunch. For these people, eating "on the job" means staying at their work site and may mean ingesting contaminants with their food.

STUDY QUESTIONS

1. List the different ways a Health and Safety Committee can investigate workplace hazards, relating it to your own workplace. What methods would be easier at your workplace; which would be more difficult, and why?
2. Describe the measures that can be used to control carcinogen exposures. Which methods are preferable and why?
3. Describe the uses and limitations of the MSDSs.

Module 6

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MassCOSH Fact Sheet APPENDIX A

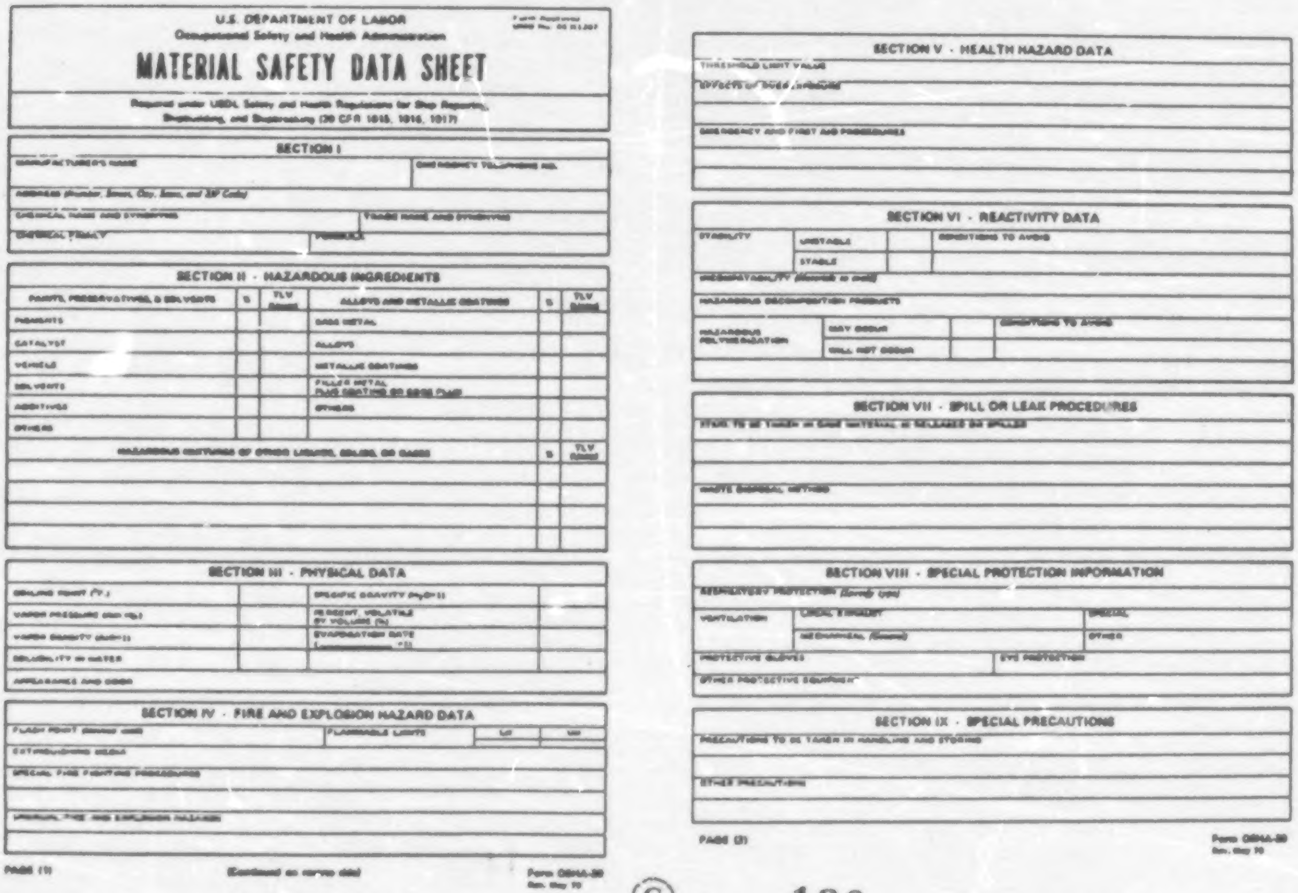
Material Safety Data Sheets

WHAT'S IN THIS STUFF? One way to find out is to get hold of a Material Safety Data Sheet (MSDS), a form OSHA requires companies to fill out who manufacture and use dangerous products.

Not all chemicals, oils, or agents in the workplace must be described in an MSDS. OSHA only requires it for those substances that pose a health hazard to workers if used without special precautions. Substances in this category include explosive and corrosive materials, chemicals with low levels of permissible exposure, and strong oxidizing and reducing agents.

A Material Safety Data Sheet identifies a hazardous product, its manufacturer, its hazards to safety and health, and precautions to follow when using it.

A MATERIAL SAFETY DATA SHEET LOOKS LIKE THIS:



U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

MATERIAL SAFETY DATA SHEET

Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

SECTION I

SECTION II - HAZARDOUS INGREDIENTS

SECTION III - PHYSICAL DATA

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

PAGE (1)

SECTION V - HEALTH HAZARD DATA

SECTION VI - REACTIVITY DATA

SECTION VII - SPILL OR LEAK PROCEDURES

SECTION VIII - SPECIAL PROTECTION INFORMATION

SECTION IX - SPECIAL PRECAUTIONS

PAGE (2)

THE INFORMATION IN A MATERIAL SAFETY DATA SHEET BREAKS DOWN AS FOLLOWS:

Section I	Identifies the product and its manufacturer.
Section II	Hazardous Ingredients. Lists almost all product ingredients for which OSHA has a standard, along with their Threshold Limit Values (TLVs).
Section III	Physical Data. Lists certain chemical data--but no health hazards. Can be useful in deciding how dangerous a product is. (MassCOSH can help you interpret this information.)
Section IV	Fire and Explosion Data. Gives the flash point of the material --the temperature at which the material will ignite in the presence of a spark or flame. If the flash point is near or below 100°F., the material is particularly dangerous--hot weather, static electricity, or a cigarette can set off a fire or explosion.
Section V	Health Hazard Data. Often gives poor quality information. Short-term hazards may be listed, but not long-term ones like cancer.
Section VI	Reactivity Data. Gives info on conditions that could cause the product to react dangerously or to decompose and release dangerous materials.
Section VII	Spill or Leak Procedures. Gives instructions for handling spills.
Section VIII	Special Protection Information. Lists protective equipment and proper ventilation to be used with the material--probably the minimum measures.
Section IX	Special Precautions. Lists handling, storage, and other special safety measures.

IT'S IMPORTANT TO UNDERSTAND WHAT DOESN'T APPEAR ON AN MSDS. Often companies only list ingredients with TLVs or low flash points, even though many toxic materials don't yet have a TLV because OSHA has not yet set a standard. The quality of the information is often poor, and long-term hazards, even very serious ones like cancer, are not listed in many cases. Also manufacturers sometimes list only the general class of an ingredient and not its specific name. Finally, OSHA is unable to check the accuracy of any of the information.

DESPITE THESE SHORTCOMINGS, THE MSDS CAN BE USEFUL. To get an MSDS, send a letter to the manufacturer of the product requesting a copy or request that your employer furnish a copy. (Under OSHA's Right-to-Know standard, your company must open its health and safety files to workers on request.) Writing to the manufacturer on your union's stationery (or asking MassCOSH to write on your behalf) will better your chances of getting an MSDS. But company response--even when favorable--is often slow, so don't be surprised if a reply takes 4-6 weeks.

Log and Summary of Occupational
Injuries and Illnesses

Depar
Division

NOTE: **This form is required by Public Law 91-596 and State of California Labor Code, Section 6410 and must be kept in the establishment for 5 years. Failure to maintain and post can result in the issuance of citations and assessment of penalties.** *(See posting requirements on the other side of form.)*

RECORDABLE CASES: You are required to record information about every occupational death; every nonfatal occupational illness; and those nonfatal occupational injuries which involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment (other than first aid). *(See definitions on the other side of form.)*

Company Name
Establishment
Establishment

Case or File Number	**Date of Injury or Onset of Illness**	**Employee's Name**	**Occupation**	**Department**	**Description of Injury or Illness**	**Extent of and C** **Fatalities**	Nc
Enter a nonduplicating number which will facilitate comparisons with supplementary records.	Enter Mo./day.	Enter first name or initial, middle initial, last name.	Enter regular job title, not activity employee was performing when injured or at onset of illness. In the absence of a formal title, enter a brief description of the employee's duties.	Enter department in which the employee is regularly employed or a description of normal workplace to which employee is assigned, even though temporarily working in another department at the time of injury or illness.	Enter a brief description of the injury or illness and indicate the part or parts of body affected. Typical entries for this column might be: Amputation of 1st joint right forefinger; Strain of lower back; Contact dermatitis on both hands; Electrocution—body.	Injury Related Enter DATE of death. Mo./day/yr.	In
(A)	(B)	(C)	(D)	(E)	(F)	(1)	(2
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					TOTALS (Instructions on other side of form.) →		

CAL/OSHA No. 200

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Certification

CAL/OSHA

State of California
tment of Industrial Relations
of Labor Statistics and Research

For Calendar Year 19 ______

Page ___ of ___

Form Approved
O.M.B. No. 44R 1453

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onfatal Injuries					Type of Illness							Fatalities	Nonfatal Illnesses				
juries With Lost Workdays				Injuries Without Lost Workdays	CHECK Only One Column for Each Illness *(See other side of form for terminations or permanent transfers.)*							Illness Related	Illnesses With Lost Workdays				Illnesses Without Lost Workdays
ter a **HECK** injury volves ys away m rk, or ys of stricted rk tivity, both.	Enter a **CHECK** if injury involves days away from work.	Enter number of **DAYS** *away from work.*	Enter number of **DAYS** of *restricted work activity.*	Enter a **CHECK** if no entry was made in columns 1 or 2 but the injury is recordable as defined above.	Occupational skin diseases or disorders	Dust diseases of the lungs	Respiratory conditions due to toxic agents	Poisoning (systemic effects of toxic materials)	Disorders due to physical agents	Disorders associated with repeated trauma	All other occupational illnesses	Enter **DATE** of death. Mo./day/yr.	Enter a **CHECK** if illness involves days away from work, or days of restricted work activity, or both.	Enter a **CHECK** if illness involves days away from work.	Enter number of **DAYS** *away from work.*	Enter number of **DAYS** of *restricted work activity.*	Enter a **CHECK** if no entry was made in columns 8 or 9.
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					(a)	(b)	(c)	(d)	(e)	(f)	(g)						

INJURIES

ILLNESSES

of Annual Summary Totals By ______________________ Title ______________________ Date ______________

No. 200

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MODULE 7: THE IMPACT OF CARCINOGENS ON THE ENVIRONMENT

Lesson Objectives:

By the end of this session, students will be able to:

1. Identify the sources of community exposure to carcinogens.

2. Describe the ways in which a worker's family can be affected by workplace carcinogens.

3. Give examples of how environmental contamination in one part of the ecological system can affect the rest of the system.

Special Terms:

Bioaccumulation
Biodegradable
Decomposers
Ecosystems
Food chain
Food web
Herbivores
Material Cycle
Minamata Disease
Mutagens
Nitrogen-fixing bacteria
Transplacental Carcinogens

Teaching Method:

Lecture
Class Discussion
Audio-visual Presentation

Special Preparation:

1. An excellent text for background information for this Module is Chapter 32 of Mader's Inquiry into Life. (See Reference # 18.)

2. Two useful audio-visual tools for this Module are Part 1 of the film, Song of the Canary (see Reference # 10) and, if available through Public Television, In Our Water (see Reference # 28).

3. Choose news articles from the media watch project that discuss community water contamination (choose a local example if possible). Make copies to distribute for the class discussion on page VII-16. For further reading about the health effects associated with contaminated water, see the book Malignant Neglect (Ref. # 14) and the article by Makfong Zaki (Ref. # 30).

4. For further reading about the details of PBB contamination discussed on page VII-17, see the readings by Corbett, Egginton and Halbert (Reference #'s 8, 13 and 16).

Review Material:

1. Review the assignment given in Module 6. Discuss students' experiences in attempting to investigate workplace and community carcinogen exposure and worker and neighborhood activities to control those exposures.

2. Review Media Watch articles.

Assignments:

1. Assign selected readings and study questions.

2. Assign two students to the Media Watch project.

3. Conduct the group taped interviews, presenting information learned in Modules 1-7. If possible, the interviews should be conducted with a group of workers or community residents who are exposed to the carcinogens that the student began investigating in Module 6 or who are involved in activities to control those carcinogens.

4. Continue with the workplace and community carcinogen investigation assignment from last week.

MODULE 7: THE IMPACT OF CARCINOGENS ON THE ENVIRONMENT

I. Introduction

Although workers potentially receive the highest exposure to carcinogens at their jobs in the factory, exposure to family members and to neighbors in the community is becoming a problem of increasing concern. Our environment functions as a balanced system. Workplace and other environmental carcinogens that disrupt that balance can cause significant problems at all levels of the system.

Too often, people do not see the link between a polluting factory, the water it pollutes and their own health and well-being. A review of certain basic ecological principles will help students begin to understand the environment's fragile balance and the potentially serious consequences of environmental contamination.

II. Ecosystems and How They Work

A. Overview

Our environment is made up of numerous communities of living and non-living things, all of which are linked together by their effects on one another and their responses to the environment they share (Whittaker, 1975). A pine forest, a stretch of desert and a high mountain lake are all examples of natural communities. Each community relates closely and interacts continually with its surrounding environment.

An ecosystem is a unit in nature consisting of a community of organisms and the environment in which that community is located. Ecology is the study of the interactions within and between the ecosystem and its external environment. The whole world can be viewed as an ecosystem or each individual system such as the pine forest mentioned above can be considered an ecosystem. The concept of ecosystems is important because an "ecosystem is independent of external sources of matter and energy, other than light from the sun" (Owen, 1974). Water and other materials essential for life are circulated through the interrelationship between the members of the ecosystem itself. These natural recycling systems, called material cycles, are essential mechanisms for carrying life-giving nutrients to organisms in the ecosystem.

Another important component of ecosystems are food webs. In any natural system, there are numerous levels of life, each related to the others by its food source. The three major categories of animals within an ecosystem are herbivores, carnivores and omnivores. The feeding relationship between these groups is called a food chain. Several food chains linked together are considered a food web.

Natural cycles and food webs carry essential life-giving materials to organisms within their ecosystems but they can also carry contaminants throughout the system. So closely are humans related to other living organisms through food webs and natural cycles that an entire population can be contaminated through food and other sources.

B. Natural Cycles

The water, nitrogen and mercury cycles are examples of naturally occurring substances whose cycles have been upset by human activities that either disrupted the fragile balance within the ecosystem or contaminated the ecosystem with pollutants.

1. The Water Cycle

Water pollution usually occurs locally through direct dumping or leaching. See the examples of fertilizer runoff and industrial waste pollution in Figure 1. Contamination of water systems can also occur through the global transport of water vapor through the evaporation phase of the water cycle. Contaminants and airborne materials, which have been carried on air currents to the upper atmosphere, return to earth when it rains.

Figure 1: Water Pollution

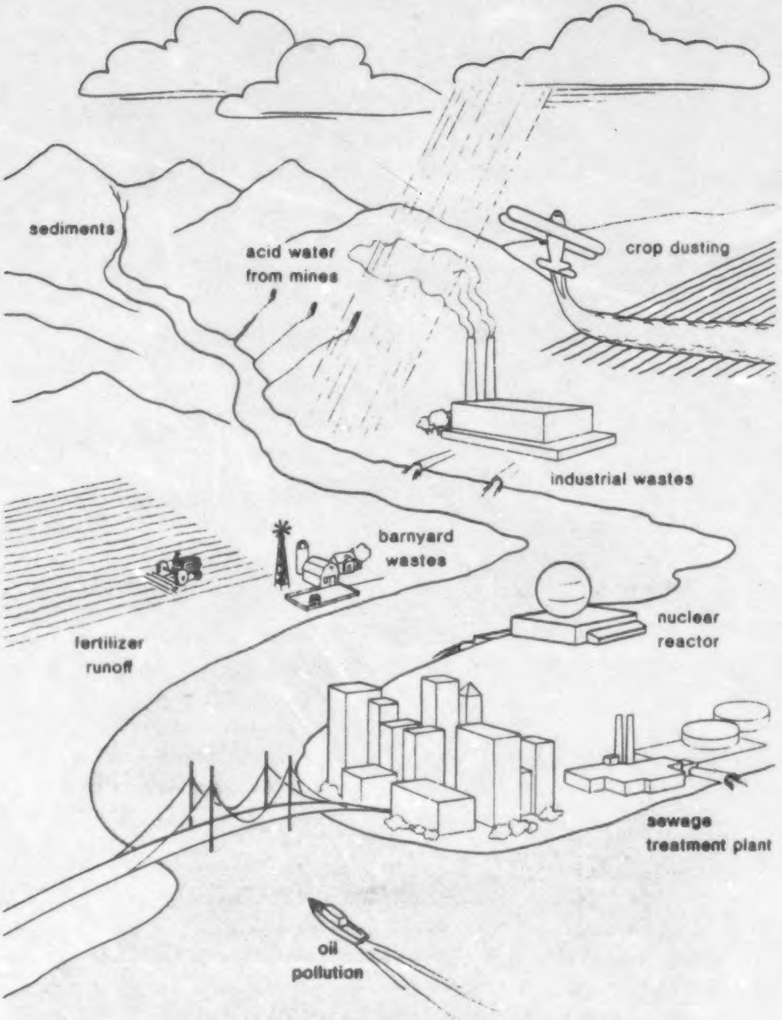

sediments
acid water from mines
crop dusting
industrial wastes
barnyard wastes
fertilizer runoff
nuclear reactor
sewage treatment plant
oil pollution

Figure 1: shows the many ways that humans cause surface water pollution. In addition, groundwater is also subject to pollution. Chemicals drain from hazardous waste dumping sites, and bacteria and viruses drain from septic tanks and cesspools into the ground and may eventually reach either aquifers or surface waters.

Source: From Mader, Sylvia S., Inquiry Into Life, 3rd Ed. (c) 1976, 1979, 1982 Wm. C. Brown Company Publishers, Dubuque, Iowa. Reprinted by special permission.

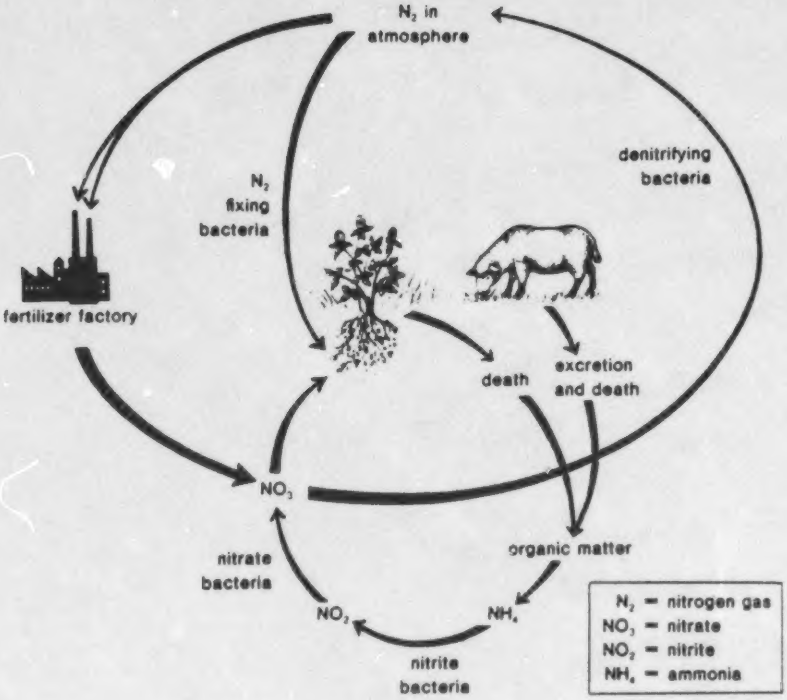
The problem of acid rain is a serious example of this global cycling of contaminants through the water cycle. Both sulphur dioxide emissions from coal-burning power plants, smelters and factories and nitrogen oxides from car exhausts and industry, rise into the air and are carried by winds for hundreds of miles. These chemicals mix and react with water vapor to form sulphuric and nitric acid which then fall to the earth in the form of rain or snow. Over time this acid rain causes a shift in the natural acid content of lakes and streams, thereby affecting all levels of fresh water life. If the process continues, life can no longer exist and the lakes eventually become sterile. Acid rain also affects other forms of life. Scandinavian scientists believe that acid rain has caused a 15% reduction in timber growth. The acid also erodes stone statues, limestone buildings and metal roofs. The long term effects of acid rain are of serious concern to scientists and to government officials who must regulate sulphur dioxide emissions (Time, 3/17/80).

2. The Nitrogen Cycle

Nitrogen is one of the essential elements of life, used by living organisms to make amino acids. The majority of nitrogen (N_2) in the atmosphere is not usable by most organisms. However, there are two types of nitrogen-fixing bacteria which convert N_2 into the useful forms of nitrates (NO_3). Only nitrates can be taken up by plant roots and converted to amino acids. Animals then acquire the nitrogen by eating the plants.

Fertilizer is another source of nitrates which is added directly to the soil. In terms of energy, however, nitrogen-fixing bacteria are much more efficient than human-made fertilizer. Refer to the Nitrogen Cycle in Figure 2.

Figure 2: The Nitrogen Cycle


N_2 in atmosphere
denitrifying bacteria
N_2 fixing bacteria
fertilizer factory
death
excretion and death
NO_3
organic matter
nitrate bacteria
NO_2
NH_4
nitrite bacteria
N_2 — nitrogen gas
NO_3 — nitrate
NO_2 — nitrite
NH_4 — ammonia

Nitrogen cycle. Three types of bacteria are at work: nitrogen-fixing bacteria convert aerial nitrogen to a form usable by plants; nitrifying bacteria, which include both nitrite and nitrate bacteria, convert ammonia to nitrate; and the denitrifying bacteria convert nitrate back to aerial nitrogen again.

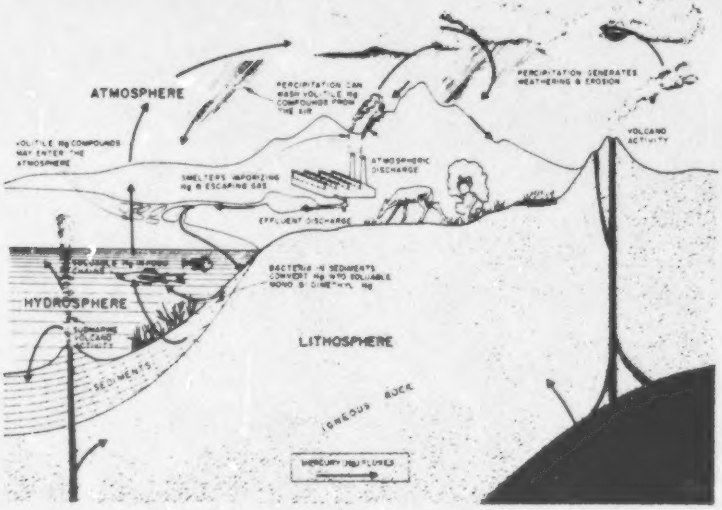
Source: From Mader, Sylvia S., Inquiry Into Life, 3d Ed. (c) 1976, 1979, 1982 Wm. C. Brown Company Publishers, Dubuque Iowa. Reprinted by special permission.

One problem associated with using synthetic fertilizers is that the biological system can become overloaded with more nitrates than it can handle. Rather than being absorbed by plants, the excess nitrates leach out of the soil and into the water table. Once substances enter the water table, they can move to other bodies of water via the groundwater which functions as a reservoir below the ground. When nitrates collect in freshwater lakes they cause overgrowths of algae. On farms with their own wells, excessive amounts of nitrates have been found in the water. When ingested, nitrates can be converted by the bowel into nitrites which then interfere with the transportation of oxygen throughout the body. When there is inadequate oxygen in the blood, infants can develop a bluish or purplish skin discoloration known as cyanosis.

3. The Mercury Cycle

The cycling of mercury, described in Figure 3, depends upon the breakdown of insoluble metallic mercury into mono and dimethylmercury which is usually soluble and can be absorbed by living things. As with nitrogen, bacteria in soil and sediments in water systems are necessary to change mercury from one form to another.

Figure 3: The Mercury Cycle


ATMOSPHERE
PERCIPITATION CAN WASH VOLITILE Hg COMPOUNDS FROM THE AIR
PERCIPITATION GENERATES WEATHERING & EROSION
VOLITILE Hg COMPOUNDS MAY ENTER THE ATMOSPHERE
VOLCANO ACTIVITY
ATMOSPHERIC DISCHARGE
SMELTERS VAPORIZING Hg & ESCAPING GAS
EFFLUENT DISCHARGE
SOLUABLE Hg IN FOOD CHAINS
BACTERIA IN SEDIMENTS CONVERT Hg INTO SOLUABLE MONO & DIMETHYL Hg
HYDROSPHERE
SUBMARINE VOLCANO ACTIVITY
LITHOSPHERE
SEDIMENTS
IGNEOUS ROCK
MERCURY (Hg) FLUXES

The mercury cycle in the biosphere centers upon the relative environmental mobility of certain compounds of the element. Mono and dimethyl mercury is evolved by the action of certain aerobic bacteria upon elemental (metallic) mercury. These compounds are soluable, become mobile, and enter the food chain where they tend to be concentrated.

(Source: DeSanto, 1978)

A tragic example of excessive mercury build-up in the environment and contamination of the food chain occurred in Minamata, Japan. In 1953, people living around Minamata Bay in Japan began developing a range of symptoms that included tunnel vision, lack of muscular coordination, loss of speech and hearing, emotional disturbances, coma, and even death. This illness, which came to be known as Minamata disease, was traced to the ingestion of methyl mercury compounds dumped into Minamata Bay by Chessor Corporation, a chemical plant in the small Japanese town. Mud near the factory's water channel contained greater than 2000 ppm* of mercury. Tested fish and shellfish contained up to 50 ppm compared with 1 ppb in sea water. (The average mercury concentration in the ocean is .03 ppb.) Humans showed an increase in mercury levels in urine, blood, hair, brain, liver and kidney. Originally, it was thought that mercury was not water soluble and therefore would not move through the environment. Recent studies show however, that mercury can be converted into different forms that are not only water soluble in the environment but can also be absorbed through cell walls and so can enter the food chain (De Santo, 1978 and Smith, 1975).

C. Food Chain Contamination

The tragedy of Minamata occurred because mercury, cycled through the environmental food chain by natural processes, accumulated in certain living organisms which were in turn eaten by other animals or by humans.

DDT is another example of chemical contamination through the food chain. DDT was a commonly used pesticide throughout the world.

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*PPM stands for "parts per million." This means the number of parts of a particular substance in a million parts of the surrounding environmental substance such as air, water, soil, etc. It is a measure of the concentration of a chemical. PPB stands for parts per billion and PPT, parts per trillion. These denote successively smaller concentrations than PPM. The greater the toxicity of a chemical, the smaller the amount necessary to show adverse effects. For example, the extremely toxic chemical 2,3,7,8 TCDD, one of the class of chemicals called dioxins, has caused cancer in rats at a level of just five parts per trillion (PPT) (Corbett, 1977).

Approximately 50% of the DDT used on land was carried into the atmosphere to make world-wide distribution possible.

Table 1 DDT Average Worldwide Dispersal

Soil	2-10 ppm
Ground water	0.001-0.2 ppm
Surface water	0.001-0.2 ppm
Rain	0.1-0.3 ppb
Trade winds	0.1-0.3 ppb
Human fat	6-12 ppm
Beef fat	0.5 ppm
Deep oceans	0.00 ppb

Source: (DeSanto, 1978)

Although its effect on humans has not been established, DDT is toxic to certain organisms in high concentrations and can cause hormonal and reproductive system changes at lower exposure levels (DeSanto, 1978). Some water-soluble chemicals can be rapidly metabolized and excreted by the body. DDT, however, is not very water soluble but is very fat-soluble so is stored and accumulated in the fat of the animals and humans who ingest it.

Studies of DDT concentrations at various levels of the food chain indicate that this pesticide accumulates in concentration as it moves up the chain. This phenomenon is called Bioaccumulation or Biomagnification. Table 2 illustrates the Bioaccumulation of DDT in a terrestrial food chain.

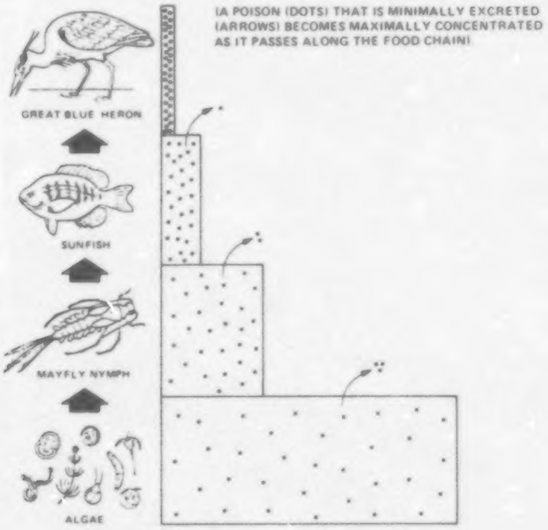
Table 2: Concentrations of DDT at Various Levels of the Food Chain

DDT Conc.	Location
9.9 ppm	Soil from forest sprayed with DDT to control Dutch Elm Disease
141 ppm	Earthworms in forest
444 ppm	Robins (body fat) from the same forest

(Source: DeSanto, 1978)

The graphic representation of bioaccumulation in Figure 4 may also be helpful in presenting these concepts. In this figure, the poison increases in concentration as it moves up the food chain. For example, concentration at the algae level would be parts per trillion (ppt), at the mayfly nymph level, parts per billion (ppb), at the sunfish level, parts per million (ppm) and at the great blue heron's level, parts per thousand (no abbreviation for this term).

Figure 4: Bioaccumulation in an Ecosystem.



(A POISON (DOTS) THAT IS MINIMALLY EXCRETED (ARROWS) BECOMES MAXIMALLY CONCENTRATED AS IT PASSES ALONG THE FOOD CHAIN)

Source: From Mader, Sylvia S. Inquiry Into Life, 3d Ed (c) 1976, 1979, 1982, Wm. C. Brown Company Publishers, Dubuque, Iowa, Reprinted by special permission.

D. Natural Clean-Up

All natural systems have the ability to reconstitute, or clean themselves up, if contamination does not continue. Contaminating chemicals decompose through reactions with sunlight (photodecomposition), through the action of bacteria (microbial decomposition), or through various chemical reactions.

A good example of natural system clean-up ability is the success story of Lake Erie. In the late 1960's, Lake Erie was considered one of the most polluted bodies of water in the world. The Cuyahoga River, which empties into Lake Erie, was so polluted with oil and other debris that it caught fire two times. Dead fish and rotting algae washed ashore on the local beaches. Fear of high mercury and DDT levels caused commercial fisheries to close. Sports fishing was banned. Only boating was allowed to continue.

In the past decade, however, the Canadian and U.S. governments have jointly undertaken major cleanup efforts. Billions of government dollars have improved sewage treatment plants and money from private industry has cleaned up industrial discharges. Toxic chemicals, however, such as PCBs and mercury, remain a serious problem - levels are still too high to allow commercial fishing. The lake's natural self-cleaning process is slowly tackling this major task (Time, 12/2/79).

The example of Lake Erie is encouraging to environmentalists. However, some systems can take thousands of years to become "clean" again. Chemicals that contaminate groundwater will decompose only slowly because there is no light and few microorganisms to facilitate the clean up process.

The natural clean-up of radiation depends on the half-life of the radioactive substance i.e.. the time required for half of the atoms to disintegrate. Certain types of radiation, such as Uraniam or Thorium, have extremely long half-lives; for example, the half-life of Uranium-228 is 4.5 billion years. Discussing their natural clean-up potential is of no practical value. Limits on the earth's ability to clean up radiation is illustrated by the case of the Bikini Atol, a group of thirty small islands 2000 miles southwest of Hawaii. In 1946, the U.S. government dropped an atomic bomb in order to study nuclear blast effects on naval ships and equipment. Prior to the test, the Bikini islanders were removed from the target island and relocated to islands out of the test zone. Thirty-one years later, in 1977, the Bikinians were allowed to return home only to be reevacuated because radiation levels on the island were still excessively high.

III. Environmental Contamination and Community Health

Because our environment is complex, individuals in the community may often be exposed to multiple doses of a contaminant through several exposure sources.

A. Paths of Exposure

1. Chemicals brought home from work on a worker's clothing

If proper protective clothing and changing facilities are not provided at work, many workers are forced to wear their work clothes home or to take them home to be cleaned. Wives and children of workers exposed to carcinogens such as asbestos and vinyl chloride on the job have developed cancer from exposure to contaminated work clothes (Anderson, 1979 and Bellin, 1981).

Class Discussion:

Many workers do not have facilities for washing up and changing despite the known presence of contaminants in their workplace environment. Since some people are not familiar with the industrial environment, they do not realize how important this route of exposure can be and how easy it is for this contamination to take place.

a. Has anyone in the class ever worked on a job where he or she was exposed to contaminants which accumulated on their workclothes during the course of the day? If yes, were they provided with changing facilities and/or showers? Students should describe their experiences.

b. If showers are provided at the worksite, many workers are expected to clean up on their own time. (Remind students that for certain chemicals, workers must change and shower each time they enter the workplace including lunchtime). This often leads to people changing and showering at home. Discuss how this problem could be eliminated.

c. Since many workers are unaware of the potential hazards of the material with which they work, very few think of the potential impact of this exposure on their families' health. Families are equally unaware of the problem. In a survey of blue collar workers, workers reported that they would turn to their families for support on health and safety problems at work. Discuss why it is important to include families in these occupational safety and health programs organized by management or by unions.

2. Environmental Pollution from the Factory

The primary sources of environmental contamination are air pollution, water pollution and pollution of the food chain.

a. Air Pollution Residential areas surrounding a factory are usually blue collar neighborhoods. People who are exposed at work may also have the highest community exposure. Levels of air pollution in neighborhoods are often affected by prevailing wind patterns. Lower air currents disperse contaminants in the immediate community. One example of this is the contamination of air with radioactive materials in areas surrounding uranium handling facilities. Uranium milling waste materials at a facility in Salt Lake City exposed individuals in the neighborhood of the piling to estimated radiation doses to their upper respiratory tracts of 1400 millirems per year (Eckher, 1981). This is 28 times the Nuclear Regulatory Commission's standard for maximum public exposure.

Upper air currents will carry pollution far beyond the surrounding neighborhoods and can create global pollution problems as discussed earlier with acid rain. Air carried in upper air currents is not usually inhaled directly. Contaminants carried in these currents are usually washed to earth through rain or snow storms. The pollution carried in upper air currents can travel great distances. In 1953, for example, nuclear fallout radiation measurements from atomic bomb tests indicated that radioactivity from one such test in Nevada was carried across the country to Boston, Massachusetts where it exposed citizens to 1900 millirems for a two day period (Panati, 1981).

Above ground nuclear testing was discontinued in the U.S. in 1963. However, fallout was still descending to the earth 1-2 years after the tests. Since 1965, fallout levels have decreased, but with new countries conducting atomic bomb testing, levels are again expected to rise (Ecker, 1981; Panati, 1981; Sternglass, 1981).

b. Water pollution

There are several major sources of water contamination:

- Direct dumping into local streams, rivers or lakes
- Leaching into surface or groundwater from legal or illegal toxic waste dumps
- Agricultural runoff
- Rainfall through contaminated air.

The effect of water contamination depends upon the contaminant, its concentration and whether or not it affects surface or groundwater.

Certain types of chemicals such as dioxins and PCBs cannot be broken down by natural systems. These are non-biodegradable chemicals.

These chemicals will remain in the environment for thousands of years.

Class Discussion:

Discuss the impact of water pollution on the health and well-being of the community. If possible, use local examples of water contamination for this project chosen from the Media Watch Project described in Special Preparation #3. Address as many of the following questions as appropriate based on the amount of information in the article.

1. Identify the area where contaminated water has been found.

2. Describe which population areas, if any, use this water and whether the water is used for drinking, swimming, fishing or boating.

3. What contaminants have been identified in the water? What are the levels detected? Have the sources of the contaminants been identified? If so, what are they?

4. What health hazards have been associated with exposure to each of these contaminants? At what exposure levels were these health effects identified?

c. Pollution of the food chain

Pollution of the food chain can occur through several avenues:

- Uptake of toxic materials by fish and other aquatic organisms from contaminated water.

- Uptake and assimilation of chemical contaminants from water sources by plants.
- Pesticide chemical accumulation in plants and then in animals through bioaccumulation.
- Direct addition to food by manufacturers of chemical preservatives, food additive, etc.

There are numerous examples, in addition to Minamata, which can be used to demonstrate the impact of food contamination on the entire ecosystem. The case of PBB contamination in Michigan may be one of the most tragic.

Beginning in the summer of 1973, Michigan residents were exposed to Polybrominated Biphenyls (PBBs) in their food for a three year period: in their milk, beef, chicken, eggs, pork and other livestock. This food chain contamination resulted from the Michigan Chemical Corporation's mislabeling of two products: Nutramaster, a feed additive, and Firemaster, a flame retardant chemical made with PBBs.

The Firemaster, labeled as Nutramaster, was added to feed for dairy cows by the Michigan Farm Bureau and distributed throughout Michigan. This feed was also mixed with other livestock food resulting in the ultimate destruction of thousands of cows, chickens, eggs, and pigs.

The full story of PBB exposure, and the subsequent response of local, state and federal government officials is a chilling example of the potentially wide-spread ramifications of food chain contamination on a community.

3. Exposure Through the Reproductive System

A less usual but serious route of exposure for a worker's family is through the reproductive system. Damage can occur through a variety of paths at different points in the reproductive cycle of growth and development: prior to conception, during pregnancy and in the newborn.

a. Mutagenic substances cause genetic damage to the father's sperm or to the mother's ovum (egg cell) prior to conception and can be passed on to the fetus. DBCP (a pesticide) and lead are two well-known examples of substances known to affect genetic material and associated with sterility, miscarriages and birth defects.

b. Chemicals which affect the fetus directly during pregnancy are called teratogens. The cells of an embryo or fetus grow and divide rapidly, making them much more vulnerable to toxic substances than an adult's. Most harmful substances which enter the mother's blood circulation reach the developing fetus through the placenta. These substances can have an especially harmful effect during early pregnancy when the major organ systems are developing. Transplacental carcinogens cross the placenta, contaminate the fetus and cause cancer to develop later in life. So far, the only known human example of this is DES (diethylstilbesterol). Between 1941 and 1971, DES was given to pregnant women to prevent miscarriage. After a latency period of about 15 years, many of their teenage daughters have developed cervical cancer. Some of the sons born to these women have developed testicular cancer. Radiation also may affect the developing fetus. There is strong evidence to suggest that fetal exposure to radiation (for example, medical x-rays) increases the chances of developing childhood leukemia. (Chavkin, et al., 1980)

c. After childbirth, a baby can be exposed to chemicals transmitted through the mother's breast milk. DDT, PBB, lead, mercury and cadmium are all known breast milk contaminants.

B. Effects on the Family's Health

The discussion of the various paths of exposure illustrates the complexity of environmental contamination. It is difficult to determine the combined health effects of so many contaminants together, especially since the levels of carcinogen exposure in the environment are usually very low. The concentration of most contaminants are in the parts per billion range. Individual susceptibility varies greatly throughout a community, making it difficult to predict the adverse health effects. Newborns and old people are in an especially high risk category while workers are usually younger and healthier and so are at lower risk of developing disease.

It is also difficult to associate particular contaminants with specific illnesses because most illnesses resulting from environmental contamination are chronic (long-term) illnesses. Cancer, the topic of this course, is only one example; others include chronic respiratory and kidney disease, allergies and reproductive damage, all of which can also be caused by toxic environmental exposures.

Reproductive damage (sterility, miscarriages, stillbirths, physical birth defects, behavioral and learning problems and cancer) is of concern for several reasons:

- Substances capable of causing reproductive damage are also potentially capable of causing cancer. Since the reproductive cells appear to be more sensitive to some chemicals than are other cells, because the cells of the rapidly growing fetus divide frequently and because reproductive damage usually appears sooner than other chronic illnesses, reproductive damage may be one of the first indicators of chemical contamination in a community. Mutagenic substances which cause changes in the genetic material of the sperm or the egg are closely linked to carcinogens which also cause genetic changes. Reproductive damage might therefore signal the existence of a carcinogen.

- Reproductive hazards have a potentially serious effect on the health of children and of future generations

Class Discussion:

1. Use Appendix A to discuss the range of health effects which can result from exposure to reproductive hazards and the workers who are at highest risk.
2. Despite the sensitivity of reproductive cells and of cells in the developing fetus, the reproductive effects of contaminants may go undetected for several reasons. Ask the class for possible explanations, including a discussion of the following:
   - the results of many mutations are not immediately perceptible at birth
   - people may hesitate to discuss with non-family members sensitive issues such as sterility or the birth of a deformed child because they feel personally responsible since they are unaware that a toxic substance may be responsible.
   - it is difficult to prove a cause-effect relationship between a child's illness and the parent's occupational exposure.
   - epidemiological studies are expensive and take time.

STUDY QUESTIONS

1. Discuss why Bioaccumulation is a serious hazard to community health and well-being.

2. If leakage from a toxic waste dump kills microorganisms (decomposers) in the surrounding soil, what impact would that have on the Nitrogen Cycle and the ecosystem's ability to reconstitute itself?

Case Study:

Residents of Contra Costa County, California are concerned that high levels of air pollution from five oil refineries and 37 chemical plants in the county are responsible for lung cancer rates which are 40% higher in industrial sections of the county than in non-industrial areas. But a preliminary report on the continuing study by the State suggests that "the higher lung cancer rate in males is due to occupational hazards rather than the air they breathe." The Director of the Cancer Epidemiology Section of the California Department of Health Services added that the lower lung cancer rates found among women tend to bear out his hypothesis (New York Times, 3/28/82).

Comment on this situation. What additional information would you need to determine whether or not this air pollution was contributing to the high lung cancer rates in the community.

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Appendix A

Some Known Reproductive Hazards and Associated Occupations For both Men and Women

	HAZARD	EFFECTS	OCCUPATIONS
MEN	Cadmium	Damage to blood system of testes and other reproductive organs	Storage batteries, smelter workers
	DBCP	Sterility, chromosome damage	Pesticide and agricultural workers
	Manganese	Impotence and decreased libido	Welders, ore smelters
	Chloroprene	Chromosome damage, decreased fertility, miscarriage among wives of exposed workers	Rubber workers
WOMEN	Mercury	Teratogenic effects	Pesticide workers
	Dioxin	Teratogenic effects	Agricultural workers
	Polychlorinated Biphenyls (PCBs)	Teratogenic effects	Electrical workers, microscopists
	Chlorinated Hydrocarbons	Possible carcinogen, transmitted through mother's milk	Dry cleaners, degreasing operations
AFFECT BOTH MEN & WOMEN	Anesthetic gases	Miscarriage, infertility in women, chromosome damage	Operating room personnel
	Diethylstilbestrol (DES)	Menstrual disorders in women Gynecomastra and lowered libido in men, cancer in female offspring, genital abnormalities in male offspring	Drug manufacturers
	Benzene	Chromosome damage	Chemical workers, lab technicians, degreasing operations
	Lead	Abortion, miscarriage, stillbirth, teratogenic effects, altered sperm, lowered fertility and libido	Storage batteries, smelter workers, police
	Radiation X-Ray	Low fertility, sterility, birth defects, cancer in offspring	Health workers, atomic workers, drug workers

Sources: References #'s 5, 6, 22, 25, 26)

MODULE 8: REGULATING CARCINOGENS

Objectives;

By the end of this session, students will be able to:

1. Describe the procedure by which carcinogens are regulated.
2. Discuss several ways that the public can have input into the regulatory process.
3. Identify the primary federal agencies empowered to regulate carcinogens in the workplace and in the community.
4. Explain the scientific, economic and political factors that affect the standard-setting procedure for carcinogenic agents.

Special Terms:

Cost-benefit analysis
EPA
FDA
Intrinsic value
Market Value
OSHA
Right-to-Know Laws

Teaching Method:

Lecture
Class Discussion
Class Debate (optional, if time; see Study Question #6)
Guest Presentation - OSHA employee (optional)
Small Group Discussions - Break into the same small groups as in Module 4.
The group should appoint a chairperson and a notetaker and should discuss:

- Findings from their investigation of workplace and community carcinogens.

- A summary of the activities already taken by workers or by community groups to control those carcinogens.
- Relevant information from the taped interviews.
- Discuss study question #2 in relation to each group's specific carcinogen problem and based on the information discussed in this module.
- Using all the information collected, outline a carcinogen control program for the workplace or community (see Assignment #3). Different components of the program proposal can be divided between different students or each student can develop an entire proposal individually to present during the last class discussion.

Special Preparation

Contact a local OSHA office, (or a local COSH group, union) to get information about OSHA and about relevant regulations:

1. If possible, have a local OSHA representative attend the class to discuss OSHA activities and to answer students' questions about the standard-setting process and Right-to-Know legislation.
2. If your state or city has local Right-to-Know legislation, obtain a copy or have the OSHA representative bring a copy to class. Discuss with the class the questions listed under Class Discussion (pg. VIII-20).
3. Obtain other general brochures about OSHA and its functions to distribute to students.

Review Material

1. Review Module 7 study questions
2. Discuss Media Watch articles
3. Collect the taped interviews; review them and select several for use in Module 9.

Assignments:

1. Assign selected readings and study questions. Study questions #1 and #6 will both take some additional research beyond the material that is presented in the module. Sections of Epstein cover these issues more thoroughly. Study question #3 involves administering a questionnaire. This is optional, depending on students' time limitations and on the class's time frame.

2. Assign two students to the media watch project.

3. Individual students should develop their program proposals (in entirety or one component of the group's proposal). The final presentation should include:
    a. A summary of the major carcinogen exposure problems and how you investigated them.
        - What are the hazards?
        - What are the known health effects, routes of entry into the body, etc.
        - How many people are exposed, where and when?
        - How did you investigate those hazards and what problems did you encounter in your investigation? (e.g. Requested MSDS from employer or manufacturer; obtained a copy of monitoring records from an OSHA investigation; contacted the local Air Quality Management District office for information about air pollutants from a local factory; etc.)

    b. What type of controls already exist?

    c. Describe the past and current union or community activity.

    d. Outline a proposal for future action such as developing or expanding a workplace Health & Safety Committee or organizing community activities. Discuss possible solutions to the problems of carcinogen exposure and the barriers to implementing those solutions. Specify activities that a community or worker group could organize:

- training and education in the workplace and the community; include suggestions for motivating people to become involved.
- workplace control measures needed
- contract language
- OSHA complaint
- publicity, including press involvement
- political action - activities around cuts in government regulatory agencies, new standards, etc.

MODULE 8: REGULATING CARCINOGENS

I. The Regulatory Process

A. Overview

Carcinogen regulation is one of the most hotly debated issues among government, industry and labor sectors. Standard-setting, a major component of the regulatory process, is an especially controversial issue. Since there is no known safe level of carcinogen exposure, the process of setting a standard for a substance (determining a value which environmental exposure levels may not exceed) is more often based on economics and politics than on sound scientific information. The government is responsible for the tremendously challenging job of balancing the concerns of various public and private interest groups. The regulatory process involves Congress, various federal agencies and the courts:

1) Congress passes laws which provide the legal basis for further action.
2) Federal agencies set standards and establish administrative policies based on the laws passed by Congress and on input from the concerned groups. Before a federal agency sets a standard, it must solicit input from as many areas of society as possible. The result is usually a collection of extremely divergent opinions. Industries constantly accuse federal agencies of over-regulation or "heavy-handedness," while consumer or worker advocacy groups complain of a lack of concern for the public's interest.
3) Once a standard is set, the courts may become involved to determine whether or not Congress' original intent as stated in the law is being carried out appropriately.

Regulation, then, is the process of balancing an agency's legal or statutory authority with various political influences and pressures; actions are then subject to court system review.

Class Discussion:

Survey the class's attitudes about carcinogen regulation by asking the question: "If you were to develop legislation or policies for regulating carcinogens, how would you address the following issues?" Begin the discussion by listing each of the following categories on a separate sheet of large paper. Add the class's comments and post each one around the class for later reference.

- o Chemical toxicity testing: when should it be done...after the product is marketed or before?
- o Criteria for determining carcinogenicity: epidemiology, animal, or bioassays?
- o Burden of proof: should the government be required to prove a chemical is dangerous or the manufacturer required to prove it is safe?
- o Economics: should cost-benefit considerations affect the standard-setting process? Who should pay the costs for rectifying problems, e.g. clean-up of toxic waste sites, purification of contaminated water?

B. The Standard-Setting Process: The Example of OSHA

Setting standards for allowable exposure levels of different substances is a major function of regulatory agencies. Issuing a standard is a lengthy process which can take from one to several years and is designed to solicit maximum public participation. The following steps illustrate OSHA's process and will differ depending on the agency:

1) A proposal for a new OSHA standard or modification to an old one can be initiated in a variety of ways:
   - o proposal by the Secretary of Labor
   - o petition by an interested group -- labor union, public interest research group or trade association

- information submitted by a nationally-recognized standard-setting organization
- action by the Secretary of Health and Human Services (HHS) or the Director of the National Institute for Occupational Safety and Health (NIOSH). NIOSH, the research arm of OSHA, is responsible for evaluating workplace substances. NIOSH researchers submit criteria documents to OSHA which contain evidence of risks associated with workplace hazards and a regulatory proposal to control those risks

2) OSHA drafts a proposal for a standard

3) The proposal undergoes review, possible modification and approval.

4) The review and comment period includes:
   - publishing a Notice of Proposed Rule-Making in the Federal Register
   - a comment period to solicit information which is reviewed and may be incorporated into the proposed standard
   - a second comment period allows for written comment or testimony at public hearings
   - a post-hearing comment period

5) The records are closed, all the data is evaluated and the standard is promulgated by the Secretary of Labor

C. Public Input

Labor and community involvement is essential to insure environmental carcinogen control; the regulatory process provides for public input in several ways:

1) By electing representatives to Congress who will favor environmental protection and by pressuring them to enact favorable legislation. Pressure can take the form of lobbying in Washington (e.g. unions played an active role in lobbying for passing the OSHAct) or of mass protest action (e.g. when the mine workers went on strike to force passage of the Mine Health and Safety Act).
2) Input into the standard-setting process in a particular agency. The public can petition to request a standard, send written testimony in response to a notice in the Federal Register or testify in person at a hearing during the comment period (an important role for a union's national Health and Safety staff person).
3) In the Court system the public can bring suit against agencies when they neglect their responsibilities or can testify in favor of proposed regulations when industries sue the agency.

II. Federal Regulatory Agencies

The primary federal agencies responsible for protecting workers and the public from carcinogen exposure are the Food and Drug Administration (FDA), the Consumer Product Safety Commission (CPSC), the Environmental Protection Agency (EPA), and the Occupational Safety and Health Administration (OSHA).

A. The Food and Drug Administration (FDA)

The FDA is primarily responsible for assuring the safety of all foods, drugs, cosmetic devices and related products marketed in the U.S. The laws below give the FDA power to regulate both "natural" and "added" substances. The FDA also regulates environmental contaminants such as PCBs or mercury which can accumulate in food. Legislation provides the FDA with regulatory power:

1938 - the Federal Food, Drug, and Cosmetic Act: 1) Prohibits the marketing of food that contains "a natural or added substance which may render it injurious to health" and forces the manufacturers to prove the safety of any additives; 2) Requires drug manufacturers to test and label drugs before they are marketed and 3) allows the FDA to regulate cosmetics if they can prove the presence of a hazardous substance in a product.

Amendments to the original act include:

1954 - Pesticide Residue Amendment
1958 - Food Additive Amendment
1960 - Color Additive Amendment
1968 - Animal Drug Amendment

(Epstein, pg. 376-380)

The Delaney Amendment, part of the 1958 Food Additive Amendment, is probably the most controversial piece of federal carcinogen legislation. It prohibits the addition of any substance which causes cancer in laboratory animals to food. This amendment provided the basis for FDA attempts to ban saccharin. The Delaney Amendment is important because it is based on two important and controversial principles: it accepts animal testing as a means of predicting cancer in humans, and it assumes that there is no safe level of exposure to a carcinogen. These two issues are continually debated among all government, public, industrial and institutional groups (Merril, 1980).

B. Consumer Product Safety Commission (CPSC)

The Consumer Product Safety Act of 1972 was intended to protect the public against unreasonable risks of injury associated with consumer products. The Act established the Commission and gave it responsibility for over 10,000 consumer products. During its early years, the CPSC concentrated on the more visible safety hazards and ignored the health hazards of chemical-containing products. In the mid-1970's, consumer groups such as the Health Research Group and the Environmental Defense Fund began pressuring the Commission to ban the use of certain hazardous products which have potential long-term health effects. Since then, the CPSC has initiated attempts to ban the following products:

Vinyl chloride use as a propellant in household products
Chlorofluorocarbon propellants
Asbestos consumer products
Tris - a fire retardant in children's sleepwear

Consumer products containing benzene
Formaldehyde

When CPSC proposes to ban a product, it can ban all current and future use of the product, therefore requiring all existing products to be recalled and destroyed. Or it can limit the ban to future production of the product, thereby leaving some of the product in circulation (Merrill, 1981).

Class Discussion:

Discuss the health and economic implications of banning all current and future use of a carcinogen versus banning only its future use. List arguments in favor of each type of ban on the blackboard (or on butcher paper) as they are mentioned by students in the class. Consider both the implications to the public's health of allowing any exposure to a carcinogen versus the economic implications of removing all carcinogens currently in use.

C. Environmental Protection Agency (EPA)

Six laws determine the EPA's ability to limit carcinogens:

1) The 1970 Clean Air Act provides broad authority for establishing air quality standards for pollutants from stationary sources (industries) and from mobile sources (cars, trucks, etc.); also regulates fuel additives, etc.
2) The 1948 Federal Water Pollution Control Act as amended in 1970 and 1977 is used for setting standards to control toxic substances that empty into water bodies from industrial discharge sources, agricultural run-off and city drainage.
3) The 1947 Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) as amended to the Federal Environmental Pesticide Control Act (FEPCA) in 1972 establishes a procedure for registering pesticides. Pesticide manufacturers must provide evidence of

pesticide safety when petitioning the EPA for registration. They are then registered either for general use or for restricted use by trained applicators. The EPA is also responsible for establishing acceptable levels of pesticide residues on food (the FDA then tests food samples and is responsible for enforcement).

4) The 1974 Safe Drinking Water Act regulates the purity of treated drinking water.
5) The 1976 Toxic Substances Control Act requires chemical manufacturers to submit data to the EPA before marketing a chemical for a new use. Thus, it establishes a system for controlling chemicals before they are marketed rather than attempting to control them by reacting after the product has been marketed and has caused health problems.
6) "Superfund" legislation was enacted in 1980 to correct the serious environmental problem of poison leakage from toxic waste dumps. Chemical and petroleum industry taxes would finance 86% of the proposed $1.6 billion program.

(Epstein pp. 361-374)

Although Congress has legislated extensive authority to the EPA to regulate environmental carcinogens, the agency has acted slowly. For example, although the EPA has established criteria for determining whether substances under its regulatory authority pose a cancer risk to humans, the criteria are recommendations rather than regulations. These criteria recognize four levels of proof of potential carcinogenicity:

1) The "best evidence" consists of epidemiological studies in humans together with confirmatory animal tests.
2) "Substantial evidence" consists of animal tests that demonstrate the development of tumors.
3) "Ancillary evidence," the least persuasive proof of carcinogenicity, consists of studies that suggest potential carcinogenicity based on chemical structure.

These criteria for carcinogenicity were published in 1976 in the Federal Register as a notice rather than as a regulation which would carry some weight. Thus, the EPA's potential regulatory power over carcinogens has not been utilized.

Pressure from public interest groups has been essential to the development of EPA regulations and standards. For example, the Environmental Defense Fund (EDF), the Health Research Group and the Sierra Club have all been instrumental in enforcing the Safe Drinking Water Act. The Act authorizes the EPA to regulate carcinogens in drinking water. However, in the first set of standards developed in 1975, the EPA included very few of the many carcinogens actually present in U.S. drinking water. Since then, the EDF has brought several suits against the EPA to force the agency to more aggressively regulate drinking water carcinogens (Highland, 1980; Trauberman, 1981; Warren & Sandler, 1981).

The EPA has only slowly attempted to enforce other legislation -- it has been hindered by budget and staff cuts and by an anti-regulatory political climate. The Toxic Substances Control Act (TSCA) mandates the EPA to examine the 60,000 chemicals in production for potential toxicity. However, since 1976, resources have been cut and the project has been almost completely abandoned.

Revisions to laws are a method of weakening the law's original intent. Besides attempting to regulate chemicals already in production, TSCA also applies to new chemicals. It states that companies must give the EPA a 90 day pre-manufacturing notice (PMN) during which time the company will test the new chemical. However, revisions to PMN requirements have excluded 3 classes of chemicals (high-weight polymers, chemicals used within one manufacturing plant that are intermediate to other products and some specialty items). Only nine of the more than 1,000 chemicals for which the EPA received PMNs between 1979 and mid-1982 were kept off the market*.

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* "The Reaganomics of Toxic Chemicals." Technology Review, 85(6), Aug-Sept. 1982.

Superfund legislation has also been subject to political foot-dragging. In 1982, $396 million was allocated for clean-up operations at 160 toxic waste disposal sites. Twenty months into Ronald Reagan's presidential term, only $80 million had been spent on 8 of the 160 chosen sites* (Alter, 1982; Science News, 1983).

D. Occupational Safety and Health Administratin (OSHA)

The 1970 Occupational Safety and Health Act guarantees to approximately 65 million workers at more than 5 million workplaces the right to a safe, healthful work environment. (Workers who are not protected include state employees, the self-employed and those protected under other federal statutes; e.g., coal miners who are protected under the 1969 Federal Coal Mine Health and Safety Act). The OSHAct established a federal agency, OSHA, to meet the Act's goal by 1) issuing standards for hazardous workplace substances; 2) inspecting workplaces to detect standards violations and other hazards; and 3) providing training and education for workers and employers.

Like the CPSC, OSHA initially concentrated primarily on safety standards. In the last 6 months, however, it has focused more attention on regulating health hazards as well.

There are three types of existing standards:

1) Consensus standards for approximately 400 substances were developed by industry or by organizations such as the American National Standards Institute before the 1970 OSHAct. They were adopted by OSHA when it was established but most do not provide adequate protection because the standards were developed to protect against immediate toxic effects rather than against delayed toxic or carcinogenic effects.

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* Alter, Jonathan. "Reagan's Regulatory Report Card." Washington Monthly 14 (9), Nov. 1982, p. 10.
"EPA Lists Dumpsites, Resists Congress." Science News, 123 (1), Jan. 1983, p. 6.

2) Permanent standards are modified consensus standards or proposed new standards and are established by the standard-setting process described earlier. They are designed to assure "to the extent possible that no employee will suffer material impairment of health." Eight carcinogenic substances are regulated by permanent standards: asbestos, vinyl chloride, coke oven emissions, acrylonitrile, DBCP, arsenic, cotton dust and lead. In addition, there is a list of 14 carcinogens which are regulated but have no concurrent requirements for monitoring exposure levels.

3) Emergency Temporary Standards may be imposed without the formal process of providing for prior notice, a public comment period or a public hearing. They are based on suspicion of "imminent hazard" and can be enforced for a maximum of 6 months. During that time period, OSHA must develop a permanent standard through the full, formal standard-setting process. Six sets of emergency standards have been developed since 1972.

Case Study:

The "Benzene Decision" is an example of how a federal agency, industry, labor and the court system each play an important role in the standard-setting process. In response to the results of an epidemiologic study, OSHA proposed to lower the existing consensus standard from 10 ppm to 1 ppm to protect workers' health. The following chronology illustrates the various steps of the standard-setting process.

The Chronology of Regulating Benzene Exposure in the Workplace:

1) Before passage of the OSHAct, the American National Standards Institute (ANSI) adopted a benzene exposure standard of 10 ppm for eight hours with 25 ppm peak concentrations. This standard was based on information identifying benzene as a cause of non-malignant blood disorders.

2) After OSHA was established by Congress in 1970, the agency was faced with the responsibility of promulgating and enforcing health and safety standards, including the ANSI 10 ppm benzene standard.

3) In 1976, NIOSH recommended a new standard of 1 ppm for 8 hours with 5 ppm ten minute ceilings and 25 ppm peak concentrations. The new standard was recommended based on the results of an epidemiologic study of workers exposed to benzene levels of 1-15 ppm. Even those workers exposed to benzene levels below the 10 ppm standard showed a higher rate of leukemia than others not exposed at all.

4) In 1977, OSHA issued an emergency standard of 1 ppm for benzene.

5) The American Petroleum Institute challenged the standard and brought OSHA to court.

6) The standard was stayed by the 5th Circuit Court.

7) The US Supreme Court reviewed the standard (AFL-CIO vs. American Petroleum Institute 100 S. Ct. 2844, 1980).

8) Eventually the Supreme Court issued the now famous "Benzene Decision." In a 5 to 4 decision, the majority of the Court believed that OSHA had not proven that lowering the standard from 10 to 1 ppm would decrease the risk of developing cancer significantly to justify

the new standard. Thus, the new standard was rejected by the Supreme Court.*

The long-term implications of the Benzene Decision are still uncertain. The precedent-setting nature of Supreme Court decisions raises important questions for the future: What level of increased cancer risk can be considered acceptable? How much of a decrease in cancer risk is necessary before the costs can be justified? OSHA and other regulatory agencies are in the difficult position of having to set standards to protect the health of working people without a solid scientific basis to do so. When challenged, they must be able to justify their decisions based on scientific documentation of the health effects of exposure, information that is virtually non-existent for low level exposure to many substances.

III. The Standard-Setting Process: A Generic Carcinogen Policy

One of the greatest problems with federal regulation of carcinogens is that the process is very slow. Most agencies have set standards on a chemical-by-chemical basis. In attempts to speed up the regulatory process, several agencies including OSHA, EPA and CPSC have promulgated what is commonly called a generic carcinogen policy.

A generic carcinogen policy attempts to define distinct classes into which chemicals can be placed based on the existing carcinogenicity research data. Each category would require corresponding regulatory action.

For example, OSHA's original proposed generic carcinogen policy defined two categories for potential carcinogens: Category 1 for proven human carcinogens and Category 2 for proven animal carcinogens. Category 1 classification would restrict exposure to that substance to the lowest feasible level through engineering and work practice controls. Category 2 classification would require rapid action to get additional data needed to make a judgment about the substance.

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* The Supreme Court did uphold the cotton dust and lead standards, also important precedent-setting decisions.

There is considerable controversy over the use of a generic carcinogen policy. Industry representatives argue against the policy of evaluating groups rather than evaluating individual chemicals for their capacity to cause cancer. But consumer and labor groups demand a quicker, more responsive regulatory mechanism than the chemical-by-chemical approach currently used to control the thousands of chemicals in use throughout our society.

IV. Right-to-Know Laws

The importance of public input into the regulatory process is evident from the above examples of union, environmental and public interest group pressures needed to pass laws and to set standards. Worker and community education about hazardous substances is the basis for effective public participation. While Right to Know (RTK) Laws apply specifically to workers and workplace substances, the same principle applies to a consumer's right to know what ingredients are in the products he or she is buying.

The fundamental principle of RTK laws is that they require employers to provide the names and potential health hazards of chemicals in the workplace to employees or to community members. With this information, organized groups or individuals can utilize existing state or federal laws to pressure industry to decrease carcinogen exposure and can pressure Congress and federal agencies to regulate hazards that are now not adequately controlled.

Only a partial federal RTK law is currently in effect. However, by spring of 1982, RTK laws had been passed by 7 state legislatures and 5 city governments and were being considered in some 20 other states and municipalities. The specific provisions of state laws may vary from place to place, but the principles behind them are the same. New York State legislation is one example.

Employees have the right to:

- request information about the toxicity of substances in use,

- o refuse work with no effect on pay if the requested information is not provided within 72 hours,
- o access to their records of exposure,
- o freedom from discrimination for using this law.

Employers must:

- post notices informing workers of the RTK legislation,
- maintain accurate records of employee toxic substances exposure for 40 years,
- provide training programs for individuals regularly exposed to toxic substances when they are intitially assigned to the job and annually thereafter.

Before RTK legislation, industry was not required to provide either the identity or the hazards of workplace chemicals to workers. Without this type of information, it was extremely difficult for workers to investigate hazards and to take individual or collective action to protect themselves.

In most places, industry opposition to Right-to-Know legislation has been intense. In Cincinnati, for example, where a recent RTK law was passed, the Chamber of Commerce actively fought the passage of the law, citing the "high cost of meeting the RTK bill requirements." Chamber of Commerce representatives raised two key issues in the RTK debates: "materials in commerce should not be regulated by a city," and trade secrets must be protected (State of California, 1982; Melville, 1981; Occupational Health and Safety, 1982).

The history of proposed federal RTK legislation provides an interesting example of the politics of the occupational health regulation process:

1) The original Hazards Indentification Standard, also known as the "Labelling Standard," was proposed during the last days of the Carter administration. It was finally promulgated for public hearings after a 4-year rule-making procedure and after years of pressure from labor groups.

2) However, within 30 days of Reagan's inauguration and before Thorne Auchter's appointment as head of OSHA, Secretary of Labor Donovan rescinded the proposed rule.

3) Pressure from various labor groups forced the administration to reintroduce legislation known as the "Worker's RTK" or Labelling Standard.

4) NIOSH and the AFL-CIO were among the groups presenting critical testimony about the revised legislation. They complained of severe deficiencies:

   a) the new labelling standards would require warnings rather than chemical identities. Without access to specific identifying information, workers could not research hazards themselves.

   b) It is left to the employers' discretion to determine which substances should be labelled as proposed in the standard.

   c) the legislation exempts substances which are considered trade secrets.

   d) the requirement for listing ingredients on the label covers only those ingredients that comprise at least 1% of the mixture. (Some substances are hazards at concentrations lower than 1%).

   e) the proposal is limited to manufacturing industries, excluding the workers in service, transportation, construction, agriculture, and other sectors. NIOSH noted that many of these industries use more potentially toxic substances than do manufacturing industries.

   f) MSDS's and other chemical hazard information will be available only to current employees. Thus, individuals who develop a disease such as cancer after a long latency period could not request information about their exposures from a former employer and individuals who are currently exposed could not request information anonymously.

Industry has also fought attempts to pass federal RTK legislation. The need for federal RTK legislation is obvious from several statistics: current OSHA standards set exposure limits for approximately 450 substances, but there are labelling requirements for only a few. Of 65,000 trade name products surveyed by NIOSH, approximately one half contained chemicals regulated by OSHA and more than one third were considered trade secrets. Thus, there are potentially a large number of hazardous chemicals for which there are no identifying labels for workers, either because OSHA does not regulate those substances or because they are exempt as trade secrets.

By itself, the passage of RTK legislation will probably not change much for workers. It is, however, an important tool which can be used for individual or collective action. Information obtained as a result of the RTK can be used in requests for OSHA or NIOSH investigations, in compensation cases when filing grievances, and in contract negotiations.

Class Discussion:

An OSHA representative or you, as instructor, should summarize or distribute a copy of RTK legislation if it exists in your state or city. Discuss with the class the following questions:

1. Who has access to information under the RTK law?

2. Does the law provide access to both workers and community residents?

3. Are there any exemptions? e.g. to protect trade secrets, certain groups of workers who are not covered, etc.

4. What agency (agencies) enforce the law?

5. How have people been notified about the law?

6. What are some ways that the law could be better publicized, and how could people be encouraged to use it?

V. Risk Assessment

The process of regulating carcinogens is often based on the philosophy of risk assessment. Standards to control exposure levels are determined after assessing the degree to which a change in the exposure level will effect a change in the risk of developing cancer. The Supreme Court Benzene Decision was based on such an analysis - OSHA did not prove that a decrease in the exposure level would cause a significantly large decrease in the cancer rate to justify lowering the standard. The difficult decision becomes: How much risk of cancer will be acceptable? That question has been answered in three ways and implies three different approaches to regulating carcinogens: 1) "no risk" of developing cancer will be acceptable, 2) only a "negligible risk" of cancer will be acceptable and 3) it depends what the "trade-off" is - an increased risk of cancer is justified in certain situations.

Certain agencies and different political administrations may use one of the above approaches more frequently and consistently than the others, but the approach to setting standards even within a particular administration or agency will vary depending on the specific situation. Each law which requires some standard setting procedure is a response to a particular problem (toxins in drinking water or pesticide contamination of the environment) rather than part of a comprehensive, consistent approach to dealing with the threat of environmental cancer. For example, FDA policy is not even consistent within one law. The Food, Drug and Cosmetic Act makes food manufacturers, but not cosmetic manufacturers, responsible for proving the safety of their products. Because there is no consistent policy, changing administrations often result in 180° switches in regulatory approaches.

Carcinogen standards vary considerably depending on the theory of risk assessment used by the regulatory agency setting the standard.

1) The Delaney Amendment is an example of the "no risk" approach to cancer control. Because no risk of cancer is acceptable, the amendment allows no addition of a known carcinogen to food.

2) The FDA has used the "negligible risk" approach for regulating a carcinogen added to hair spray, and for regulating some carcinogenic animal drugs that remain in animal tissue which is then consumed by humans. The "negligible risk" approach assumes that the presence of the carcinogen will result in only a small degree of carcinogen exposure to the public and so will cause a negligible increase in the risk of developing cancer. After much debate, the FDA defined negligible risk as an increase of no more than 1/1,000,000 additional cancer cases that will result from exposure to a carcinogen at or below a set standard.

3) The "trade-off" approach does not establish a set level of acceptable risk, but weighs the health risks associated with a given exposure level against other factors, such as technological feasibility and economic cost of complying with that standard.

A. Cost-Benefit Analysis

The practice of weighing both the costs and the benefits of a standard in the regulatory decision-making process is called cost-benefit analysis. As most commonly used, the costs that are measured are costs to the employer of complying with a regulation and the benefits are those that accrue to the worker as a result of the regulation. If the benefits outweigh the costs, the regulation is enacted. If the costs are greater, the regulation may be abandoned or weakened. When debating a regulation, industry representatives pose the question, "Can we afford the economic burden a new standard will impose?" and labor representatives and environmentalists ask, "Can we afford not to set those standards?" Two important questions arise in a discussion of the validity of using cost-benefit analysis to regulate carcinogens: 1) From what viewpoint are the costs and the benefits being analyzed? and 2) How does one accurately and objectively measure such factors as health, air quality, etc.?

B. How to Look at Cost-Benefit Analysis?

Costs and benefits are usually analyzed from the viewpoint of setting a proposed standard; i.e., what are the costs to the employer of complying with the standard, and what are the benefits to the employee of a better workplace and community environment? This viewpoint places the employer in a more sympathetic light than the opposite viewpoint in which costs and benefits are defined in the absence of a standard; i.e., the employee bears the cost of ill health from a polluted workplace or environment and the employer receives the benefits of increased profit-making potential.

From one viewpoint, the dollar value of the cost of complying with standards includes the cost of pollution control equipment and work process changes. From the other viewpoint, the cost of damages done in the absence of measures such as air pollution control would include health care costs, the cost of laundry, painting, replacing corroded metal, days lost from work and premature death.

C. How to Measure Costs and Benefits?

Cost-benefit analysis is used in the regulatory process as a supposedly objective economic test. However, it is difficult enough to compute the dollar value of the costs mentioned above: engineering controls for air pollution, health care costs from respiratory damage, etc. Other costs of air pollution such as the tension and distress at home resulting from a chronic invalid with emphysema are even more difficult or impossible to estimate.

The dollar cost of setting or not setting a standard is its market value. The value of something which cannot be defined in dollar terms, such as clean air or the beauty of a lake, is its intrinsic value.

Theoretically, costs and benefits can be objectively measured; in practice, cost estimates are often subjective and biased. Many of the factors that influence cost estimates overestimate the cost of compliance and underestimate the benefits of regulation, thereby "stacking the deck against analytic conclusions promoting the needs of worker safety and health" (Ruttenberg, 1981).

Ruttenberg describes these factors as follows:

- Most data sources used in regulatory analyses come from industry files: thus, cost estimates may be inflated.
- Costs and benefits can be interpreted in a variety of ways. Industries can inflate cost factors by including costs of basic, work-related research under the headings of "innovative research development" or "compliance research and development."
- Costs of compliance are based on the use of "current level technology" to control exposure. However, when forced to do so, industries have developed cheap, efficient ways of complying with the standard. The OSHA Act allows for OSHA to set "technology forcing standards;" i.e., standards that may be difficult to comply with currently but that can be met if employers put money into researching new methods of controlling the hazard.
- Cost-benefit analysis does not usually include the industry's profit margins which can be used for hazard abatement and pollution control equipment.

D. Cost-Benefit Analysis in the Regulatory Process: The Vinyl Chloride and Cotton Dust Standards

In addition to the Benzene Decision, two other recent decisions have important implications for the role of cost-benefit analysis in the carcinogen regulatory process.

The development of the vinyl chloride (VC) standard illustrates how industry's use of cost-benefit analysis can result in inaccurate estimates and so bias the standard-setting process. VC, used in manufacturing plastics, causes a rare form of angiosarcoma of the liver (a type of cancer). After OSHA proposed a "no detectable" standard for worker exposure to VC, the plastics industry responded that the standard could not be met. They claimed that the standard was medically unnecessary, technologically unfeasible, would lead to a loss of as many as 2.2 million jobs, and would cause sales losses as high as $65 to $90 billion. OSHA raised the ceiling to a 1 ppm standard which the plastics industry still protested. However, not only was the plastics industry able to meet the new standard at a much lower cost than initially predicted, but the new technology developed to control exposure also made it possible for industries to recover and recycle the VC that had previously been lost. Thus, the VC standard is an example of a "technology-forcing" standard.

The Cotton Dust Standard, imposed during the Carter administration to control byssinosis (brown lung disease) has also been the topic of much controversy. On June 17, 1981, the Supreme Court ruled on the validity of using a cost-benefit analysis in setting the Cotton Dust standard. Their decision states that OSHA cannot require exposure controls that are impossible to achieve nor that will bankrupt an entire industry. However, benefits to workers' health must always carry more weight in the decision-making process than the economic costs to industry. Their decision states that "Congress itself decided the basic relationship between costs and benefits by placing the 'benefit' of the worker's health above all other consideration" when it wrote the law in 1970. Since federal agencies must comply with the intent of the law when establishing regulations, they are also bound to prioritize workers' health.

In summary, the regulatory decision-making process is subject to politics. Worker and community groups should take collective action to influence the process in whatever way possible. Theoretically, the entire process allows for public input to advance the public's health status. However, legislation and regulations are only as good as the agency's enforcement abilities. The OSHA Act authorizes OSHA to enforce the standards it sets but its ability to do so depends on the amount of resources available. Thus, good legislation and regulations can effectively be stymied by an unfavorable political administration that implements budget cuts in its regulatory agencies.

STUDY QUESTIONS

1. Choose either the Safe Drinking Water Standard or OSHA's Vinyl Chloride Standard, both legislated to regulate toxic chemicals. Outline the role of self-interest and public interest groups in the development and implementation of the standard.

2. Choose an occupational or environmental carcinogen exposure problem that you have been investigating in your workplace or community. What factors would you need to know in order to determine the cost of correcting this problem? Evaluate the costs of different methods of workplace carcinogen control discussed in Module 6. Consider both market value and intrinsic value in determining the cost.

3. Identify five things which have intrinsic value that are affected by the specific community carcinogen problem you are investigating in your workplace or community. Develop a list of questions which will determine how much people value these particular things. Administer these questions to 10 people in the workplace or community who are affected by the carcinogen problem.

4. In your opinion, what is an acceptable risk of cancer from chemical exposure? (e.g. one death per 100,000; one death per thousand). How can you justify your opinion?

5. While the Supreme Court is demanding more scientific proof before making decisions, very often the evidence is not yet available. For instance, the Benzene case is a good example of the inability of the court to decide an issue because of lack of information. What should OSHA do in this instance?

6. Class Debate
   A debate over FDA's proposed ban of saccharin and Congress's eventual overturning of the regulation is a very good topic for classroom debate.

   Resolved: Saccharin is a proven animal carcinogen and should therefore be banned from all products utilized for human consumption.

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MODULE 9: PREVENTING CANCER

Lesson Objectives;

By the end of this module, students will be able to:

1. Discuss a concept from each of Modules 1-8 as it relates to the specific case of asbestos.

2. Describe the types of cancer that asbestos exposure can cause.

3. Discuss several methods of asbestos control, explaining the advantages and disadvantages of each.

4. List several factors that illustrate the need for primary prevention programs to control cancer, using the specific example of lung cancer and its association with asbestos and smoking.

Special Terms:

Asbestosis
Mesothelioma
Health Belief Model
COSH groups

Teaching Method:

Lecture
Class Discussion
Role Playing
Guest Presentation/Guest Panel Discussion
Small Group discussion to prepare for final presentation

Special Preparation:

1. Contact representatives from 2-3 local labor unions whose members are exposed to carcinogens and from 2-3 local environmental or community action groups who are involved in issues that affect union members. Ask them to attend this or a final session to discuss as a panel:
    - What activities does their group focus on?
    - What links have been made between the groups?
    - What do the different groups see as their common interest?
    - Have the groups worked together on joint activities? If so, how were they coordinated? If not, why?

2. Select several taped interviews for the group to listen to and discuss.

Review Material:

1. Prepare evaluation/feedback mechanism for students. Ask the same list of questions discussed in Module 1 (pg. I-17) and compare the current responses with the list of responses noted at the first session (pg. I-5,6).

2. Distribute or obtain an evaluation form and/or assign #3 below for students to complete in class or at home.

Assignments:

1. Assign the asbestos study problem.
2. Prepare for final presentations.
3. Evaluate the class, answering the following questions: Briefly review your notes from each session and identify one or two areas of the course which were particularly difficult to understand. Why were these difficult? Could the method of presenting that material be changed in the future to better assist someone like yourself in learning this material?

MODULE 9: PREVENTING CANCER

I. Asbestos: A Case Study

Each of the concepts presented in the previous modules illustrates the need for a primary prevention approach to cancer control. Asbestos can be used as a case-study to review these concepts and to stress the need for collective action to prevent cancer.

A. Overview of the Problem: Extent of Asbestos Exposure and Effects

Asbestos is a natural mineral made up of fine white fibers. Because it is strong and able to withstand heat, it has been used in a wide variety of products ranging from insulation to hand dryers to brake linings. Over 5 million tons of asbestos are produced worldwide annually (Selikoff & Lee, 1978).

During World War II, a staggering number of workers were exposed to asbestos which was used as insulation in naval ships. An estimated 4.5 million men and women were employed in US naval and civilian shipyards (Selikoff, 1979, p. 299). These workers were exposed to higher than normal levels of asbestos because the government set aside protective measures in order to speed up naval ship production during the war.

Construction work is another major source of exposure. Three quarters of the asbestos used in the United States each year is used in the construction industry. In addition, many other workers are exposed who may never imagine that they come in contact with asbestos -- pipe fitters who are exposed because most piping is protected with asbestos and office workers who are exposed when ventilation systems lined with asbestos release fibers into the air.

Asbestos exposure can cause severe health problems:

- o Asbestosis, a debilitating lung disease, is characterized by fibrosis (scarring) of the lungs. It has been known since the early 1900's to result from asbestos exposure and, together with other non-infectious pulmonary diseases, was responsible for almost 10% of all deaths.

Asbestos has also been linked to three types of cancer:

- Asbestos-associated lung cancer was first reported in 1935. It accounts for 20-25% of all deaths in some groups of heavily exposed workers.
- Mesothelioma is a rare form of cancer of the lining of the lungs. It was linked to asbestos exposure in the 1960's and is the cause of death in more than 5% of all asbestos workers.
- Gastrointestinal cancer, has been most recently linked to asbestos exposure. It includes cancer of the esophagus, stomach, colon, and rectum and accounts for approximately 10% of all deaths.

(Brodeur, 1980 and Selikoff, 1978)

B. Scientific Theories and Asbestos

Much about the causes of asbestosis, lung cancer, gastrointestinal (GI) cancer and mesothelioma is already known. There is very little argument that environmental exposures play a major role in causing these diseases. However, an on-going debate rages over how much disease can be explained by different types of environmental exposure. In this case, the major controversy centers on lung cancer -- is it primarily caused by occupational exposures or by smoking habits? All the factors which make it difficult to develop theories of cancer causation (discussed in Module 2) also apply to theories about asbestos-related disease.

1. Many diseases, not one -- Asbestos exposure can lead to several different diseases, but the role of asbestos exposure versus smoking differs for each. For example, the risk of developing lung cancer and esophageal cancer is greatly increased for people who both work with asbestos and smoke but smoking does not appear to affect the risk of developing other types of GI cancer or mesothelioma.

2. Latency period -- the long latency period between the various types of cancer and asbestos exposure also makes it difficult to determine

how much of a role occupational exposure and smoking each play in the development of the disease. People move, change jobs, may not remember that they worked with asbestos and may not remember when they began smoking or how much they smoked.

3. The politics of science -- Lung cancer studies among asbestos workers have had political overtones. Asbestos companies had access for years to the personnel records necessary for a large-scale epidemiologic study, but would not commission a study until 21 years after the first reports linking asbestos and lung cancer. When they finally did commission a study of 6,000 miners in Quebec, the investigators overlooked the latent period of cancer. They studied young workers (2/3 were between 20 and 44 years of age), ignoring the fact that young miners who did not have cancer at the time of the study were potential victims of lung cancer in another 20 years. Dr. Irving Selikoff has since conducted an epidemiologic study using the welfare and retirement records of the asbestos insulator's union. He reported high incidence rates of lung cancer and of mesothelioma, with latent periods of 20 and 30 years respectively.

(Kotelchuck, 1974)

Another theory proposed by the asbestos industry is that only certain types of asbestos fibers are dangerous. This theory was not substantiated in another study by Selikoff and Hammond but is still debated.

Regardless of the exact degree of importance attributed to smoking versus asbestos exposure as causes of lung cancer, cancer prevention programs should address both. Asbestos exposure cannot be ignored -- it plays an important role in the development of lung and gastrointestinal cancers and a seemingly exclusive role in the development of mesothelioma; neither can the adverse health effects of smoking be ignored, especially when combined with the health effects of asbestos exposure.

C. Physiology, Screening and Treatment

Symptoms of asbestosis, lung and esophageal cancer reflect the disease process. Scar tissue or abnormal cellular changes develop in the lungs, making it difficult for them to adequately perform their function of providing oxygen for the body's use. Common symptoms are:

1. shortness of breath
2. a persistent cough or a change in the cough patterns
3. blood in the sputum coughed up from the lungs
4. pain in the chest or abdomen, often felt as a continuous ache
5. difficulty in swallowing or prolonged hoarseness
6. rapid, large weight loss
7. "clubbing" of the fingers or toes -- an inadequate oxygen supply causes them to become rounded and the nails to flatten.

Shortness of breath during exertion is often the first symptom to appear. However, this may not occur until at least 10 years after the individual's first exposure. By then, the disease may be in an advanced state. Lung cancer is difficult to diagnose in the early stages. By the time it is detected, much damage has already occurred. The five-year survival rate for lung cancer victims is low -- 9% for whites and 6% for blacks. Low survival rates and high incidence rates underscore the importance of a preventive strategy against lung cancer.

Medical surveillance programs attempt to detect the problem before it reaches an advanced state. The following steps should be included in periodic check-ups:

1. Work history -- if the health practitioner does not ask for a work history, the individual should be prepared to state when and how long asbestos exposure occurred.
2. An examination of the lungs while inhaling can detect rales -- a dry crackling sound in the lungs.
3. Chest x-rays are used to detect lung tissue scarring or thickening of the lungs.

4. Lung function tests measure the maximum volume of air that a person can inhale. The results give early evidence of lung problems.
5. Laboratory sputum tests are used to examine for evidence of asbestos or of cancer cells.

There is currently no effective treatment for mesothelioma. Treatment for other types of cancer is only effective if it is initiated very early in the disease process. In an effort to detect disease as early as possible, CAL/OSHA standards mandate periodic exams of asbestos-exposed workers. Exams must be provided initially and every three years for employees less than 40 years of age with fewer than 10 years since initial exposure and every year for employees 40 years of age or older with 10 or more years since initial exposure.*

D. Asbestos and Cancer

Two concepts from Module 4 are of primary importance in a discussion of asbestos: 1) the synergistic effect between smoking and asbestos and 2) the "safe threshold level" controversy. The synergistic effect between smoking and asbestos exposure is visibly illustrated by data collected from a group of insulation workers and an unexposed comparison group.

	Lung Cancer Mortality Rate (per 100,000 man-years)	Mortality Ratio
1. Individuals who neither smoke nor work with asbestos	11.3	1.00
2. Asbestos workers who do not smoke	58.4	5.17 (58.4/11.3)
3. Smokers who do not work with asbestos	122.6	10.85 (122.6/11.3)
4. Asbestos workers who smoke	601.6	53.24 (601.6/11.3)

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* California Administrative Code, Title 8: General Industry Safety Order. Section 5208.

The mortality ratio for each of the three exposed groups is calculated by dividing the mortality rate of that group by the rate for the unexposed group. Smoking and asbestos exposure by themselves each increase the risk of death from lung cancer (by 5.17 and 10.85 times, respectively). Exposure to both greatly increases the risk of death from lung cancer (53 times greater risk).

The figures above illustrate the definition of synergism - when exposed to two carcinogens (asbestos and smoking) the effect is greatly multiplied and the risk of developing cancer will be many times that of exposure to either carcinogen alone.

The controversy over a "safe threshold level" applies to asbestos as it does to other carcinogens. The 5 fibers/cubic centimeter (f/cc) standard was initially recommended by W.C. Dressen of the PHS in 1938 to control asbestosis. Since that time, studies have documented the carcinogenic potential of asbestos. The current controversy revolves around the adequacy of the existing 2 f/cc standard to protect workers against all forms of asbestos-related disease. In April of 1980, Eula Bingham from OSHA and Dr. Anthony Robbins from NIOSH issued reports stating that "all available human data provides no evidence for a threshold or for a 'safe' level of asbestos exposure. Thus, standards should be set to control asbestos exposure to the maximum extent possible if asbestos cannot be eliminated or if a less toxic material cannot be substituted" (Asbestos Watch, 1980). OSHA has proposed a new asbestos standard of 0.5 f/cc; NIOSH recommends lowering it to 0.1 f/cc (Brodeur, 1980).

Unfortunately, standards must be set based on inadequate scientific knowledge and technology. The 1969 Federal standard of 12 f/cc applied only to asbestos fibers longer than 5 microns because few laboratories were equipped with the electron microscopes needed to count fibers smaller than 5 microns. However, one cannot assume that "what you can't see can't hurt you." In the case of asbestos, the smaller fibers may be the most dangerous since they can penetrate the lungs more deeply, making it difficult for the body's natural coughing defenses to eliminate them.

E. Testing Asbestos

Dr. Irving J. Selikoff recorded the mortality rates of of 632 New York and New Jersey asbestos workers from 1943-1976. The study was of great importance in widely publicizing the hazards of asbestos exposure. By 1976, 478 people had died, while only 328.9 deaths were expected (based on statistics from the US population, adjusted for age, sex and race differences between the two populations).

$$\frac{\text{Observed}}{\text{Expected}} = \frac{478}{328.9} = 1.45$$

There were almost 1 1/2 times as many deaths as expected among asbestos workers. The ratio between observed and expected deaths was even greater for lung cancer: 13.2 lung cancer deaths were expected while 93 were actually observed.

$$\frac{\text{Observed}}{\text{Expected}} = \frac{93}{13.3} = 6.9$$

The death rate from lung cancer was 6.9 times higher than expected. This incriminating evidence was then confirmed by a follow-up (cohort or prospective) study of 17,000 U.S. and Canadian asbestos workers (Selikoff, 1979, p. 91ff). Other studies have also shown a higher than expected rate of asbestos-related disease among asbestos workers' household contacts who were exposed to asbestos adhering to shoes, hair and work clothes (Selikoff, 1979, p. 387ff).

These and other epidemiologic studies are of value in providing evidence of the problem but they are essentially "body counts." Workers and the community cannot afford simply to wait for evidence after the damage has already been done. Collective action is necessary to investigate and control the source of asbestos problems in the workplace and the community.

F. Asbestos in the Workplace - Investigation & Control

Asbestos exposure can occur on any job. The list of potentially exposed workers is very long but the major categories of exposed workers include:

- Air filtration system workers
- Asbestos cement pipe makers
- Asbestos cement sheet makers
- Asbestos shingle and board makers
- Asbestos textile makers
- Automobile mechanics
- Barge builders
- Building construction workers
- Burial vault builders
- Cement insulation makers
- Cement pipemakers
- Cement workers
- Chemical workers
- Concrete runway builders
- Dam builders
- Drain tile makers
- Fireproofers
- Heat insulation makers
- Oil refinery workers
- Oil well builders
- Paint makers
- Pier builders
- Pipe and furnace fitters
- Post makers
- Pump packers
- Reservoir builders
- Sidewalk builders
- Silo builders
- Smokestack builders
- Sound insulation builders
- Stadium builders
- Storage tank builders
- Swimming pool builders
- Tunnel builders
- Vinyl asbestos tile makers
- Water pipe makers
- Welders

(Coye, OCAW pamphlet)

Workers should read labels and talk with coworkers, their union or a Health & Safety Committee to investigate the possible presence of asbestos in workplace products. Insulation is one of the most common uses of asbestos; hot water pipes, forced air heating, fireproofing, ceiling and wall insulation should all be carefully examined for evidence of deterioration into loose fibers. The OSHA standard mandates that workers shall have access to the following infomation:

- Caution signs must be posted in plants and labels attached to asbestos materials

- In workplaces where fibrous asbestos is present, employers must have initially monitored employee exposure by December of 1972. If the exposure was found to exceed the standard, the employer must then monitor at least once every six months. Affected employees or their representatives shall be given a reasonable oppurtunity to observe any monitoring required...and shall have access to the records thereof. Employees exposed to excessive concentrations must be told what corrective actions are being taken.

- Employees have access to results of physical exams only through their personal physician. Employers must provide chest x-rays, pulmonary function tests and a medical history at preplacement, each year and at termination.

The OSHA standard also mandates certain control measures which employees can monitor to ensure employer compliance and their own safety. The standard regulates engineering, administrative, personal protection and work process controls.

Engineering controls shall be the primary method of control. Examples include exhaust fans, non-spray application methods for insulating, and storage and disposal of asbestos in sealed containers.

Personal protective measures include the provision of respirators and/or protective clothing. Respirators cannot be relied on as the primary method of protection. They may only be used under limited conditions: 1) when engineering controls are being constructed, 2) when exposure is infrequent and will persist for short time periods or 3) when a work environment cannot meet the legal standard and has been granted a variance. If respirators must be used, administrative controls are recommended i.e. "rotation of personnel." Protective clothing must be provided together with laundering facilities, change rooms and separate lockers for storing work and street clothing.

Work process requirements dictate the use of proper tools and handling practices. Hand and power-operated tools must have built-in controls. As far as practicable, asbestos shall be handled wet. No asbestos products can be removed from shipping containers without being wetted, enclosed or ventilated. All external surfaces must be be kept free of asbestos fiber accumulation.

Workplace control of asbestos exposure must involve the cooperation of workers and of their employers. Employers are responsible for providing adequate engineering controls and personal protection and workers are responsible for following appropriate work practices such as vacuuming the asbestos from workplace clothing before changing to street clothes and wearing respirators when necessary.

G. Asbestos in the Environment

Asbestos is not only a serious hazard to workers; it is also a hazard to all members of the community. Workers often carry fibers home on their clothes or in lunch boxes, thereby exposing family members. Asbestos is also present in consumer products, in homes, in public buildings such as schools and in the food and water supplies of some communities. There are over 3,000 common uses of asbestos, resulting in exposure to approximately 11 million Americans since the beginning of WWII (Western Institute for Occupational/Environmental Sciences, Inc.).

Fireproofing and insulation materials containing asbestos are commonly used in building construction. Before a 1973 EPA ban, the insulation was sprayed on building structures. In 1950, more than half of all multi-story buildings constructed in the United States used some form of sprayed material. As more information accumulated about the hazards of asbestos, spray application was first banned by the New York City Council in 1972 and finally by the EPA in 1973.

Although the process of applying insulation by spraying has been banned, the material already present in buildings is a widespread source of asbestos exposure. As the building ages and deteriorates, the asbestos fibers loosen and are carried through the building's ventilation system, thereby potentially exposing everyone in the building. And construction work which requires removing old insulation or demolishing old buildings is a source of occupational exposure to construction and office workers and a source of environmental exposure to people in the surrounding community.

Community drinking water supplies are another source of environmental asbestos exposure. Levels of asbestos in the drinking water of Duluth, Minnesota ranged from 1-30 million fibers per liter. Eventually it was discovered that the Reserve Mining Company was dumping residual Taconite, an iron oxide ore contaminated with asbestos, into Lake Superior.

Asbestos-cement pipes used for drinking water distribution are also potential sources of drinking water contamination. Asbestos fibers from the pipes will not necessarily contaminate the drinking water supply, but in areas where corrosive water causes pipe deterioration, the danger of ingesting asbestos fibers in the drinking water is greatly increased.

Currently there is not conclusive proof of an association between drinking water supplies containing asbestos and an increased cancer rate; however a 1980 study in California shows a possible link between the two. Ongoing studies in other areas of the country are attempting to test the theory that the association found between occupational exposure and gastrointestinal cancer might also apply to environmental pollution and gastrointestinal cancer.

H. Regulating Asbestos

Congress, the EPA and OSHA each have a role in regulating the widespread problem of asbestos exposure.

The EPA promulgated regulations for handling asbestos material during building demolition. When working on buildings with asbestos:

- the regional EPA office must be notified before demolishing the building or disposing of asbestos material;

- the asbestos-containing material must be wetted to prevent visible emission during its removal;
- the asbestos material must be placed in a leak-proof container;
- the material must be disposed in a designated area

(Brodeur, 1980)

Unfortunately, the regulations are often neither obeyed nor enforced. In 1980, Congress declared that asbestos in schools creates an unwarranted health hazard. The Asbestos School Hazard Detection and Control Act of 1980 (Public Law 96-270) established a 10-member Asbestos Hazard School Safety Task Force to compile medical, scientific and technical information concerning the health and safety hazards of asbestos materials and to describe methods of identifying, sampling and testing materials suspected of emitting asbestos fibers. The Act authorizes the Secretary of Education to make grants to local educational agencies for visual inspection of school buildings, sampling of building materials, and appropriate tests to determine the asbestos content in materials and the likelihood of imminent danger within school buildings. The Secretary is also authorized to make long-term, interest-free loans to local education agencies for enclosing or removing asbestos-containing materials in school buildings which pose an imminent health hazard to children or to employees. Despite the potential usefulness of the Act, it was never funded.

The EPA has also been involved in the issue of asbestos-contaminated drinking water. As of 1981, there were no U.S. standards for asbestos in drinking water. A citizen's petition was granted by the Administration in October, 1979; as a result, the EPA initiated regulatory proceedings to control the use of asbestos-cement pipe. Thus, the Agency's assessment of asbestos' toxicity will include asbestos-cement pipe together with its evaluation of other asbestos-containing substances (Millette, 1981).

Asbestos is one of the substances for which OSHA has established a standard. We have already discussed OSHA's mandates for workplace controls which are designed to maintain asbestos levels within the standard. The standard itself has been reduced from 12 fibers to 5 fibers to 2 fibers per cubic centimeter of air (f/cc) over the past 10 years. A federal standard of 12 asbestos fibers longer than 5 microns per cc of air was promulgated in 1969. At the time, little was known about potential damage from fibers smaller than 5 microns and few laboratories had the equipment needed to count smaller fibers. An emergency temporary standard of 5 f/cc was enacted in December 1971 and then replaced by a permanent standard in June 1972 with the stipulation that a 2 f/cc standard would take effect in 1976. However, there is still debate about whether this standard protects workers adequately. OSHA proposed a new asbestos standard of 0.5 f/cc and NIOSH recommends a standard of 0.1 f/cc but there will undoubtedly be continuing controversy over what is an acceptable level of risk (Brodeur, 1980).

The Courts have become involved in efforts to compensate the victims of asbestos-related disease who were exposed to the high levels of asbestos that existed before the OSHA regulations took effect. The first personal-injury claim by an asbestos worker was filed in 1927. But large numbers of workers were not affected until the latency period between their exposure and the development of disease had elapsed. The mass of lawsuits began in the 1970's; currently about 24,000 people claiming asbestos-related injuries have lawsuits pending against 60 manufacturers and suppliers. According to Selikoff, another 21 million American workers have been "significantly" exposed to asbestos which could result in another 200,000 deaths (Los Angeles Times, 7/1/83).

The large number of claimants and the potential $10 billion liability of the insurance industry has had several results:

1) Asbestos companies have filed for bankruptcy, including the Johns Manville Corporation, the West's largest asbestos maker.
2) There is controversy over the best way to handle the numerous claims of asbestos workers. Some people question the ability of the court system to handle all the claims; others propose alternative methods of handling the claims; and others question the right to deprive individual claimants of their constitutional right to a jury trial.
3) Two proposed alternative methods of handling the claims include:
   - a bill that would establish a national worker's compensation system for victims of asbestos-related diseases
   - a proposal by the Manville Corporation to create an industry-wide trust fund and allow attorneys for the claimants to distribute the money to their clients.

The resolution to the problem may have important consequences for the future of other occupational/environmental disease claims. The problems posed by the necessity of dealing with such a large number of workers who have developed disease as a result of past exposures underscores the importance of developing a broad primary prevention approach to cancer control; i.e. controlling carcinogen exposure so the cancer does not develop.

The goal of controlling asbestos exposure is to prevent asbestosis and asbestos-related cancers - lung and gastrointestinal cancers and mesothelioma. Mesothelioma can be effectively controlled by eliminating asbestos exposure since asbestos appears to be the only carcinogen capable of causing mesothelioma. Lung and gastrointestinal cancers, however, are also associated with exposure to other carcinogens. Controlling asbestos exposure will help to prevent those cancers but they will not be eliminated while people are still exposed to other carcinogen sources. In the US, smoking is another major source of carcinogen exposure. Lung cancer, known to be caused by both asbestos exposure and smoking, has a high mortality rate and can only be truly prevented by controlling exposure to the carcinogens that cause it.

II. Smoking and Cancer

A. Lung Cancer - An Overview

Lung cancer is a particularly serious problem in the U.S. According to the American Cancer Society, lung cancer will account for about 15.5% of all cancer cases and 26% of cancer deaths in 1982. These rates are not uniform throughout the population. The incidence of lung cancer in men is 22%, in women, 9%. Lung cancer mortality rates have increased dramatically since 1950; male lung cancer mortality increased by 200% and female mortality by 250% between 1950 and 1977. Black male lung cancer deaths are 25% higher than white male deaths and the rates are increasing 3 times as fast (Surgeon General's Report, 1982).

There is controversy over how much lung cancer is caused by the different sources of environmental carcinogens -- occupational exposures versus environmental pollutants versus lifestyle habits. The role of asbestos exposure versus smoking is especially controversial. A discussion of all the debates surrounding that question is not warranted here. It is important to realize that each type of exposure increases the risk of developing lung cancer and the effects of combined exposure greatly increase the risk.

B. Smoking - An Overview

Asbestos exposure and lung cancer has already been discussed. A brief discussion of smoking provides an overview of the magnitude of the problem in the U.S. and of the failure to adequately control the tobacco industry's smoking promotion efforts.

- o Life expectancy at any given age is significantly shortened by smoking. For example, a 30-35 year old, 2 pack-a-day smoker has a life expectancy 8 to 9 years shorter than a non-smoker of the same age.
- o There is a dose-response relationship between smoking and lung cancer. Mortality ratios increase with the amount smoked, are directly proportional to the duration of cigarette smoking, are higher among smokers who inhale than among those who do not and increase with the cigarette's tar and nicotine content.

Economic facts about smoking illustrate the effect on the individual and on society as a whole:

- o Americans smoked 620 billion cigarettes in 1976, spending over $14 billion on cigarettes, an average of $259/smoker.

- o The National Center for Health Statistics estimated that, in 1965, smoking-related illness cost the U.S.:
  - * 77 million lost workdays
  - * 88 million days ill in bed
  - * 306 million days of restricted activity
  - * 10% of all hospital and medical expenses

The tobacco industry spends about $400 million on advertising each year. In contrast, less than $2 million was spent on National Cancer Institute anti-smoking education programs. In addition, the United States government itself contributed $97 million to tobacco companies in the form of subsidies and price supports in 1977. Unlike most products available for consumption, there is no federal agency that regulates cigarette manufacturing. Food manufacturers, for example, must list their products' ingredients on the package. The FDA, through the Delaney Amendment, bans the sale of foods containing carcinogenic chemicals. Tobacco industries need not inform either the consumers or a government agency of the additives used in their products. Although some of the ingredients are known carcinogens, they continue to be used (Epstein, 1979, p. 166).

C. Preventing Cancer - Smoking Cessation

Statistics on lung cancer and on smoking illustrate the need for both individual and collective action to prevent smoking-related lung cancer. The individual must be highly motivated in order to successfully stop smoking. However, the role of external pressures to continue smoking are often ignored because they are not easily eliminated. Smoking is considered a personal habit, so smoking cessation is approached only from an individual point of view. Programs focus on techniques the individual can use to eliminate cigarettes. Societal norms and often the smoking cessation programs themselves stress that it is the individual's free decision to smoke or not to smoke. Because smoking is considered an individual decision, the person who attempts to stop smoking and is unsuccessful is seen as a failure in his or her own eyes and in the eyes of society. However, too often the important role of external pressures is ignored: extensive tobacco industry media campaigns, life crises, daily personal and work-related stresses (e.g. the dual role of many single women as mothers and as low paid workers) and the lack of support groups.

If anti-smoking efforts are to be successful, they will have to be broader than simply encouraging individuals to quit. Both an individual and a collective approach to the problem of smoking is needed. Smoking cessation is primary cancer prevention and must be addressed from all levels - workers, employers, the community and the government. The following are some proposals drafted by the American Cancer Society in 1978. They are a good starting point for discussing a well-rounded prevention program.

- Prohibit smoking in public places, work environments and schools
- Phase out government tobacco price supports
- Reduce insurance rates for non-smokers
- Base cigarette tax on tar and nicotine content
- Establish stop-smoking programs in all hospitals and clinics
- Ban high tar and nicotine cigarettes
- Hold the tobacco industry accountable for the safety of its products through the Food and Drug Administration and the Consumer Products Safety Commission
- Coordinate various government departments' anti-smoking programs through the Department of Health, Education and Welfare (now called the Department of Health and Human Services).

III. Individual and Collective Action

Research indicates that individuals will change their own behavior or become actively involved in group efforts to make changes if they 1) know that they are personally and seriously affected by an existing health problem, 2) feel that improved health is important and 3) believe that their actions will actually have an effect (Health Belief Model). Results of this research emphasize the importance of one's knowledge and attitudes about health problems. For example, people will not get involved in actions to eliminate carcinogenic substances such as asbestos or cigarettes if they don't know that the substances do cause cancer.

Even individuals who know they are exposed to carcinogenic substances may not be motivated to act if they deny their own susceptibility. Because cancer is a frightening topic for many people, they are not willing to accept their vulnerability and instead adopt a "macho" attitude, claiming that "cancer only affects other people, not me." Some people, however, who will not admit to their own vulnerability will change their behavior when they realize that their actions (or lack of action) might have adverse effects on family members. For example, asbestos workers might be more motivated to wear protective clothing and leave it at the workplace each day if they realize that their spouses or children could develop asbestosis from exposure to the fibers carried home on their clothes. Or, X-ray technicians who claim that they are not concerned about their own health may be willing to wear a lead apron to decrease radiation exposure if they know that radiation-caused mutagenesis in sperm or egg cells can result in children with birth defects.

Even when people know they are exposed to carcinogens and believe that they or their family members are susceptible to cancer, there are still barriers to initiating behavior change (in their personal habits or participating in collective action).

Class Discussion:

Discuss reasons for people not wanting to change their own behavior or get involved in activities to eliminate workplace and community health hazards. Some factors to consider are:

a) peer pressure or social norms--it is difficult to quit smoking when others around you smoke or to wear a respirator if co-workers consider you a "chicken."

b) fear of retaliation--of special concern if there is a threat of losing one's job.

c) learned helplessness--we are not taught to be inquisitive or to be assertive about our rights.

d) lack of time and money--a person working overtime at a low-paying job in order to support his or her family will be too tired to participate in other activities.

e) lack of support from family and friends--not only must there be an absence of negative peer pressure, there must be positive support from one's peer group.

f) co-workers cannot support one another when they are alienated by working with machines in automated workplaces where there is little social interaction.

g) feelings of helplessness or pessimism about the potential for change.

Some of the barriers to change listed above can be overcome by working closely with other people. Not only does a group (e.g., a union or a community group) provide support for individual workers; it also alleviates feelings of helplessness or pessimism. However, successful group action is not necessarily easy.

Employers' and manufacturers' goal is to maximize profits. They often do not voluntarily implement controls to limit workplace and environmental pollutants because they consider those expenses a drain on the company's profits. Government regulatory agencies (the EPA, OSHA, etc.) were formed to make and enforce environmental regulations because businesses did not voluntarily implement pollultion controls and because the U.S. work force has not been sufficiently strong to pressure for better working conditions (only 25% of the workforce is unionized).

However, government agencies are subject to a wide variety of lobbying interests. For example, auto and other industries put large amounts of money into lobbying against the Clean Air Act. Worker and community groups need to form coalitions to better lobby in the interest of health and safety legislation and regulations.

Class Exercise

Role-playing is an effective method for reviewing barriers to change and the difference between collective and individual action. Form several groups of 3-4 students each. The students will represent individuals with the attitudes and behavior listed above and should choose one of the following scenarios. One individual in each group will advocate workplace or community changes; the others will role-play other conservative interests to illustrate the potential conflicts between different interest groups.

In the workplace:

1) Personal protective equipment (PPE)--one individual advocates wearing a respirator when working with asbestos; the others argue against it, listing all the disadvantages of respirator use.

2) Collective bargaining--one individual attempts to convince others that collective bargaining for strict engineering controls to decrease benzene exposure is important; the others role-play a hostile employer or manager, a union representative who is very busy and knows little about health and safety issues and an apathetic worker who needs motivation to change his or her attitudes about the importance of health and safety.

In the community:

1) A community group attempts to get a hazardous waste disposal plant shut down because levels of trichloroethylene, benzene and PCB's have been found in the drinking water. One individual represents the community group; the others represent a worker who is upset because the community group wants support from worker groups but has not yet supported the union in its recent strike, a representative from the company who feels pollution controls are too costly and a local county supervisor who is being lobbied by both interest groups and is attempting to weigh the costs and benefits.

2) A coalition of local groups is attempting to have children's soap bubbles containing formaldehyde removed from the store shelves and recalled by a large national toy store chain. One person represents the coalition; others represent a local

business, the national toy store chain, a very busy representative from a national consumer interest group who is skeptical about the importance of this particular project and a representative from a federal consumer agency who is being lobbied heavily by the toy store chain.

In each of the above cases, the specific carcinogenic substance is not as important as the role-playing process--the exact setting or specific carcinogen can be changed to examples more applicable to a particular group of students. It is also beneficial, after the above exercises have been acted out, to change the situation slightly. Again, have the groups illustrate the same scenarios, but this time several individuals (instead of just one) will advocate change. Follow this second exercise with a discussion of the importance of support from other interested individuals and of the advantages of collective action when advocating change.

Coalitions

COSH groups, Committees on Occupational Safety and Health, are examples of coalition organizations which originated in 1972. Approximately 20 COSH groups exist throughout the U.S., comprised of unions and health and legal professionals interested in controlling workplace health and safety hazards. Many of the COSH groups, formed with the help of OSHA "New Directions" grant money, provided for local worker education during the Carter administration. Under the Reagan administration, not only is the money no longer available, but worker-oriented educational materials have been recalled. Three films "Can't Take No More," Worker-to-Worker," and "OSHA," all resources to provide workers with information about health and safety hazards and with ways to organize to control exposure, were recalled because they were considered too worker-biased.

Since the cuts in OSHA funding, COSH groups have often served as local grassroots coalitions to lobby for restored OSHA funding and have helped provide technical assistance for unions that understaffed local OSHA offices have been unable to provide. COSH group functions vary from place to place, but often include the following:

1) providing technical assistance to local unions; e.g., medical screenings, educational meetings, help with forming Health and Safety Committees, etc.

2) coordinating networking efforts to lobby for occupational health and safety legislation and to monitor federal and state agencies' enforcement of regulations

3) providing public forums on workplace hazards

MARYCOSH (the Maryland COSH group) was active in the implementation of a state Asbestos Removal Law, effective in July of 1983. It mandates that employers must have a license before removing or encapsulating asbestos. Licensing is for one year, contingent upon the appropriate work practices -- protective clothing and safety equipment, site decontamination procedures, appropriate removal and encapsulation methods, procedures for handling asbestos-containing waste materials, air monitoring procedures and clean-up procedures as described in the application and as approved by annual inspection by the Department of Health and Mental Hygiene. Employees must also be certified as having completed an approved course of instruction in asbestos removal.

STUDY QUESTIONS

1. Asbestos is one of the most widely dispersed carcinogens in the United States. Although the use of asbestos in new products has decreased considerably, people in and out of the workplace are continually being exposed to asbestos. For this problem, answer the following questions about asbestos.

   1. What are the primary health hazards associated with asbestos exposure?

   2. What factors affect asbestos' toxicity?

   3. Where are the primary sources of asbestos exposure in industry and in the community?

   4. For the following jobs, describe the:

      a) type of controls which should be used to prevent asbestos expsosure.
      b) the type of PPE necessary for the job.
      c) the type of training you would offer to supervisors and to workers.
      d) work rules which you would initiate to prevent asbestos exposure.
      e) Job 1

         Five people work in an automotive repair shop. Their primary job is to do brake repair. The current method of doing the job is to remove brake linings and to blow away the dust with an air hose. Workers usually take their breaks in their work areas, and brush themselves off after work before going home. The brake linings contain asbestos.

Job 2

Two plumbers who work for a large plumbing contractor, are assigned to remove and replace the insulation around the hot water pipes in an old office building. Many of the pipes are located in a small space which they have to crawl into to work on. The insulation contains asbestos.

Module 9

References

1. Anderson, Henry A., Ruth Lilis, Susan M. Daum and Irving J. Selikoff. "Asbestosis among Household Contacts of Asbestos Factory Workers." *Health Hazards of Asbestos Exposure*, 330. New York: New York Academy of Sciences, 1979, 91-116.

2. *Asbestos Watch*, newsletter of the White Lung Association, San Pedro, CA. 1:1, (Summer 1980) and 2.1, (Spring 1981).

3. Becker, Marshal (Guest Ed). "The Health Belief Model and Personal Health Behavior." *Health Education Monographs*, 2:4 (Winter 1974).

4. Berman, Daniel. *Death on the Job - Occupational Health and Safety Struggles in the United States*. New York: Monthly Review Press, 1979 paper.

5. Brodeur, Paul. *The Asbestos Hazard*. New York: New York Academy of Sciences, 1980.

6. Chen, Edwin. "Asbestos: An Industry on the Hot Seat." *Los Angeles Times*, Section 1, July 1, 1983, 24.

7. Coye, Molly. *Asbestos: Questions and Answers on the Hazards of Working with Asbestos*. OCAW pamphlet. San Pedro, CA: White Lung Association, N.D. Pamphlet originally appeared in the handbook which accompanied the slide show "Asbestos: Fighting a Killer," produced for the Oil Chemical & Atomic Workers Union (OCAW) by Bonnie Bellow & Nick Egleson. (Available from White Lung Association, P.O. Box 5089, San Pedro, CA 90733. (213) 519-1555.)

8. Fowler, Rober A. *Asbestos Dust: Everyone's Problem*. San Francisco: Western Institute for Occupational Environmental Sciences, Inc. (WIDES). ND. (This booklet and other publications are available from WIDES, 2001 Dwight Way, Berkeley, CA, 94794.)

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10. Hammond, E. Cuyler, Irving J. Selikoff and Herbert Seidman. "Asbestos Exposure, Cigarette Smoking and Death Rates." Health Hazards of Asbestos Exposure, 330. New York: New York Academy of Sciences, 1979, 473-490.

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13. Selikoff, Irving J., E. Cuyler Hammond and Herbert Seidman. "Mortality Experience of Insulation Workers in the United States and Canada, 1943-1976." Health Hazards of Asbestos Exposure, 330. New York: New York Academy of Sciences, 1979, 91-116.

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15. Selikoff, Irving J., Ruth Lilis and William J. Nicholson. "Asbestos Disease in United States Shipyards." Health Hazards of Asbestos Exposure, 330. New York: New York Academy of Sciences, 1979, 295-311.

16. U.S. Department of Health Education and Welfare. Smoking and Health: A Report of the Surgeon General. DHEW Publication No: (PHS) 79-50066. Washington, DC: U.S. Government Printing Office, 1979.

APPENDIX A: BIBLIOGRAPHY

A. ANNOTATED REFERENCES

Anderson, Kim, and Ronald Scott. Fundamentals of Industrial Toxicology. Ann Arbor, MI: Ann Arbor Science Publishers, Inc., 1981.

This book was written to assist people in industry with little chemistry and biology background. It introduces the basic concepts and vocabulary of industrial toxicology. It is a complete and comprehensive text on the subject of industrial toxicology and contains an extensive list of references for more detailed study. This book is highly recommended as background reading for anyone concerned about industrial carcinogens.

Asbestos Killer Dust A Worker/Community Guide: How to Fight the Hazards of Asbestos and its Substitutes. London: The British Society for Social Responsibility in Science, 1979.

Asbestos Killer Dust is a thorough handbook with a clearly practical focus: helping people fight the hazards caused by asbestos exposure. The manual prepares readers to fight industry, government and, if necessary, their unions for their health. The advantages and dangers of asbestos substitutes are an integral part of this book. Each chapter includes a number of short, to-the-point "cases" which substantiate the issues raised. The text is frequently punctuated with documentary as well as comical illustrations. The political analysis of the asbestos industry in Britain and around the world is also important to the cohesiveness of the book.

The fact that this guide was written and published in the U.K. does not detract from its usefulness for a U.S. audience. The names are different but the story is basically the same. Where this does make a difference, such as addresses of manufacturers of asbestos substitutes, the information can be filled in with a little homework.

Ashford, Nicholas A. *Crisis in the Workplace: Occupational Disease and Injury*. Cambridge, MA: The MIT Press, 1976.

In this comprehensive report to the Ford Foundation, the author critically examines the entire range of issues - scientific, legal, political, economic and social, surrounding the multi-faceted problem of occupational health and safety. Since an in-depth analysis of each of the various perspectives is dealt with in separate chapters, the book serves both as a comprehensive study of specific areas of concern as well as an excellent overview of the entire range of issues, and may be read in part or in its entirety.

Bibliographic references and the OSHA Act of 1970 are included in the appendices.

Bacow, Lawrence S. *Bargaining for Job Safety and Health*. Cambridge, MA: MIT Press, 1980.

The major premise upon which this book is based is that public policy regarding health and safety in the workplace can be improved if private and public sector activities are complementary and not separate. The author analyzes how government might capitalize on the potential of labor and management to lessen job hazards through collaborative efforts and collective bargaining. The book is divided into three parts: Part I introduces the reader to the technical, economic, political and administrative problems to be overcome if hazards are to be effectively controlled; Part II evaluates the performance of OSHA in addressing these problems and offers suggestions for reform; and Part III explores the collective bargaining process through a series of case studies for the purpose of offering some ideas on how this approach can be applied to the enactment of public policy regarding occupational health and safety.

Berkley, George. *Cancer: How to Prevent It and How You Can Help Your Doctor Fight It*. Englewood Cliffs, NJ: Prentice Hall, 1978.

Several recent scientific studies are referenced and utilized in support of the thesis that nutrition, psychological factors, stress and other variables in lifestyle play a central role in the prevention of cancer. This book was written for the general public and requires essentially no scientific or medical background in evaluating the results and applicability of the findings reported.

Bowman, Malcom C. Carcinogens and Related Substances: Analytical Chemistry for Toxicological Research. New York: Marcel Dekker, Inc., 1979.

This text outlines and discusses some of the important principles and problems in the chemistry of toxicological testing and details much of the analytical methodology used in testing.

Although most useful to chemists and other scientists working in toxicological research, the book was also written to appeal to the layperson or to other scientists concerned with the investigation of carcinogens and related toxic substances.

Sections on the handling and disposal of chemicals and safety in the laboratory are also included. Extensive references can be found throughout.

Brodeur, Paul. The Asbestos Hazard. New York: The New York Academy of Sciences, 1980.

This 93-page book was derived for the most part from a conference held by the New York Academy of Sciences in 1978. It is a good introduction to the subject of asbestos. In eighteen 2-5 page chapters, topics progress from definitions, occupational exposures, and workplace controls to current and future environmental exposures and the question of social responsibility. Its length and format make this book easy and quick reading.

Brodeur, Paul. Expendable Americans. New York: Viking Press, 1973.

Expendable Americans is a detailed account of the author's investigation into workers in asbestos and chemical factories, following particularly the case of an asbestos plant in Tyler, Texas, which was shut down in 1972. It is a log documenting the mechanics of what Brodeur calls the "medical-industrial complex." Describing the activities of company doctors, "experts" and public health officials, Brodeur holds industry and the government responsible for neglecting disastrous working conditions and enforcement of the Occupational Safety and Health Act. This is a good book for anyone desiring a dose of reality about workplace health and safety as well as the frustrations involved in getting the facts and changing these conditions.

Cairns, John. Cancer, Science and Society. San Francisco: W.H. Freeman and Company, 1978.

This is a non-technical account of the cancer problem written for the general public and undergraduate biology students. It describes the scientific aspects of cancer: its origin and the varieties of cancer; the epidemiology of cancer; the history of cancer research; and the molecular genetics and fundamentals of research and treatment. It also examines cancer as a social problem, reflecting the problems of contemporary society; more specifically, the increase in life expectancy, exposure to hazardous byproducts of science and technology, and excessive personal indulgences.

The book is a well-written and fairly exhaustive review of cancer and its social aspects. However, the message with which many will take issue is that "almost all forms of cancer are caused largely or entirely by factors in our environment which vary from place to place and generation to generation."

Calabrese, F.J. Methodological Approaches to Deriving Environmental and Occupational Health Standards. New York: Wiley Interscience Publications, 1978.

This book deals solely with the biomedical basis upon which occupational health standards are, and can be, derived. It offers a good overview of how health standards are developed and explains the rationale and methodology underlying epidemiological studies and tests to determine exposure levels and effects. The author also discusses the need to develop reliable methods for testing and monitoring which can be applied to a wide variety of substances. This book is recommended for those seeking an understanding of the epidemiology and testing of industrial carcinogens, mutagens and teratogens.

Cancer Information in the Workplace: Annotated Bibliography of Educational Materials for Public and Health Professionals. NIH Publication No. 79-2001. Bethesda, MD: U.S. Department of Health Education and Welfare, 1979.

Prepared by the Cancer Information Clearinghouse for use in public worker and professional education programs, this bibliography identifies book, journal articles and audiovisual materials on a wide range of topics dealing with occupational carcinogenesis. Citations were selected and are arranged according to the audience for which they were judged to be appropriate. It is a valuable reference source for anyone interested in occupational carcinogens.

Choudhary, Gangadhar, editor. Chemical Hazards in the Workplace. Washington, D.C.: The American Chemical Society, 1981.

Based on a symposium sponsored by the American Chemical Society, this monograph describes the method of analyzing and sampling toxic chemicals and for monitoring air-borne particulates in the laboratory and work environments. A section reviewing new technologies and advances in screening and testing potential industrial toxins is also presented. This volume is technical in nature and is suitable reading for one with a good understanding of the chemical and biological sciences.

Cohen, Jerome, Joseph Cullen and L. Robert Martin. Psychosocial Aspects of Cancer. New York: Raven Press, 1982.

This book provides an inquiry into the emotional and social behavior of a public confronting the threat of cancer. By identifying and defining both the current issues in psychosocial research and the psychological and behavioral variables associated with cancer, the authors seek to answer the questions of why we fail to detect, prevent and cope with the problem of cancer. The implication is that the enlightenment of the public and utilization of the available knowledge by the public are key components in successful control.

Control and Prevention of Occupational Cancer, Report VII (1). Geneva, Switzerland: International Labour Office, 1972.

This booklet highlights the proceedings of the 58th International Labour Conference regarding the feasibility of mandating health and safety regulations of carcinogenic agents on an international scale. An introduction to occupational-induced cancer is given in Chapter I, while the laws and practices of various member countries and the problems of international regulation are briefly summarized in subsequent chapters. Two additional publications, Control and Prevention of Occupational Hazards Caused by Carcinogenic Agents (Report V, 1973) and Control and Prevention of Occupational Cancer (Report VII, 1973), contain the proposed text for international regulation, based on recommendations from responding countries, and the discussion and outcome of voting on the various provisions contained in the proposal.

Council on Environmental Quality, U.S. Department of Agriculture, Department of Energy, Environmental Protection Agency. Public Opinion on Environmental Issues: Results of a National Public Opinion Survey. 1980.

This report summarizes the results of a number of environment-related public opinion polls as well as reports on a survey performed by Resources for the Future of the Council for Environmental Quality. A number of topics are addressed, including spending for environmental protection, protecting the environment vs. economic growth, the environment vs. energy, trends in concern about the environment, knowledge, and views on regulation. Reading this report, one cannot help but be impressed with the amount of support and concern the public has for environmental issues. Both the questions asked of survey participants and the tally of responses could provide material for interesting discussions in the classroom.

Counte, Michael A. and Luther P. Christman. International Behavior and Health Care. Boulder, CO: Westview Press, 1981.

The authors, both behavioral scientists with experience in educating health care professionals, examine the basic components of health and show how the definition of health and illness exert an influence on health-related actions and attitudes. This definition is shown to be determined by personal beliefs and values and by influences emerging from the social environment. Emphasizing how health beliefs and attitudes affect various types of actions, they describe how programs can be developed to help change health behavior.

This short book assumes only a very basic knowledge of the behavioral sciences.

Creasy, William A. Cancer: An Introduction. New York: Oxford University Press, 1981.

Intended as an introductory text for non-medical biology students, this book covers a wide range of topics dealing with cancer and cancer-control. Unlike many introductory texts which are aimed primarily at presenting the scientific and physiological basis for cancer and cancer-introduction in a more easily comprehensible manner, the aim here is to present and discuss the findings of diverse areas of cancer research in addition to those focused on the etiology of the disease. Hence, chapters and sections have been devoted to such topics as the incidence of cancer, the psychological factors influencing the disease and discussion of various methods of treatment.

The book is written in a language that is largely non-technical, making it suitable reading for anyone who wants to know more about cancer and cancer research.

Cross, John G. and Melvin J. Guyer. Social Traps. Ann Arbor: University of Michigan Press, 1980.

The central thesis of this book is that a wide variety of recognized social problems can be regarded from a point of view termed by the authors as a "social trap." Put briefly and simplistically, a social trap is a situation in which people are drawn into a certain behavioral pattern for which there are immediate rewards but longterm unwanted consequences. Two examples are cigarette smoking and environmental pollution. This approach is used to explain observed behavior in response to a number of social "evils" and is focused upon the relevance of psychological learning theories in understanding social behavior. Even though this book does not specifically address individual and social behavior as it is manifested in the case of prevention of occupational cancer, the theory and discussion are applicable to it as well as to a number of other social situations.

Cullen, J.W., B.H. Fox and R.N. Isom. Cancer: The Behavioral Dimension. New York: Raven Press, 1976.

The monograph of the 1975 conference on "Cancer Control and the Behavioral Sciences" sponsored by NCI's Division of Cancer Control and Rehabilitation, this book explores the application of behavioral science theory and skills to cancer and chronic disease, particularly as applied to health care behavior, communication, and coping with cancer. While occupational cancer is not a focus here, the wide range of articles by a number of medical and behavioral scientists is useful to both the student and the professional interested in achieving a broader understanding of the contribution of the behavioral sciences to cancer prevention and treatment.

Doll, Richard and Richard Peto. "The Causes of Cancer: Quantitative Estimates of Avoidable Risks of Cancer in the United States Today." Journal of the National Cancer Institute. Vol. 66, No. 6, June 1981. p. 1192-1308.

Doll and Peto present a detailed review of existing data on current trends in cancer morbidity and mortality. This is one of the most comprehensive discussions of the various theories of cancer causation to date. The article is long and detailed, excellent for reference or for someone interested in a thorough understanding of the current debates about how much diet, lifestyle, occupation and the environment contribute to our cancer problem.

Egdahl, Richard H., Diana Chapman Walsh and W.B. Goldbeck, Editors. Industry's Voice in Health Policy. New York: Springer Verlag, 1979.

This is a special volume written by industry representatives about industry's role in health-care maintenance and delivery. The view taken is that while industry is not the answer to our health care woes, it can play a critical role in promoting the general welfare both at the community and national levels. Various health care options are examined and suggestions are made on how to initiate and encourage industry's involvement in public health.

Emmelot, P. and E. Kriek, editors. Environmental Carcinogenesis: Occurrence, Risk Evaluation and Mechanisms. New York: Elsevier/North - Holland Biomedical Press, 1979.

Although not specifically devoted to the area of occupational cancer, this monograph of the Third International Conference on Environmental Carcinogenesis (1979) contains valuable scientific discussion of the conflicting views over the incidence of occupational-induced carcinomas, the degree of risk associated with several known or suspected carcinogens, the level of risk over background that is acceptable, the efficacy of testing procedures, and the impact of continued use of toxic chemicals on the future.

Environmental Defense Fund and Robert H. Boyle. Malignant Neglect. New York: Vantage Books, 1980.

Malignant Neglect is an informative book written for a lay audience. The book begins with a definition of "the problem": cancer is an epidemic because we have not acted on the widely accepted understanding that most cancers are environmentally caused. It ends with "the solution," focusing primarily on changes individuals can make in their daily lives to reduce their cancer risk. The other aspect of the recommended solution is to get involved in the regulatory process. A comprehensive cancer policy is suggested. Sandwiched between these are nine chapters devoted to various aspects of environmental carcinogenesis including diet, drinking water, consumer products, radiation and the biology of cancer.

Epstein, Samuel S. and Joel B. Swartz. "Fallacies of Lifestyle Cancer Theories." Nature. Vol. 289, No. 5794, January 15, 1981. p. 127-130.

This article is a response to lifestyle theorists in general and in particular to Peto's review of Epstein's The Politics of Cancer. It begins by discussing the preponderance of chemical production and use in this century. Then the role of smoking, diet and occupation are analyzed. The authors conclude that the most important factors in preventing cancer are occupational exposures and smoking. Their position is that emphasizing lifestyle factors, especially when this places the blame on the individual or disregards the effects of multiple exposures on people who smoke, is misleading and unconstructive.

Epstein, Samuel S. The Politics of Cancer, revised edition. New York: Anchor Press, 1979.

Less controversial than the title suggests, this book serves as an excellent introduction to the area of occupational and environmental cancer both from a scientific and political perspective. Part I describes the epidemiological investigations of carcinogenic exposure and risk. Part II outlines several case studies on various occupational and environmental carcinogens; and Part III examines both governmental and non-governmental policies along with a discussion of what the individual can do to prevent cancer. The main thrust of the book is that cancer is preventable but requires joint individual and political action.

Appendices, abbreviations and extensive bibliographic references are included.

Fishbein, L. Potential Industrial Carcinogens and Mutagens. New York: Elsevier Scientific Publishing Company, 1979.

The overriding purpose of this book is to bring together relevant facts about carcinogenic and/or mutagenic organic chemicals and compounds of industrial importance. The chemicals and related compounds reviewed are arranged by structural categories and the test systems used to determine their toxicity, the associated risk assessment data, the results of epidemiological studies and the mode of entry into and interaction with the body are described. This book is highly technical and is useful for studies requiring detailed scientific information.

Fraumeni, J.F., Jr. Persons at High Risk of Cancer. New York: Academic Press, 1975.

Based on the proceedings of a conference, this 6-part, 32-chapter volume is aimed at identifying high-risk cancer groups both in order to learn more about the causes of cancer and to direct limited resources in such a way that those at the greatest risk of contracting cancer will receive the maximum benefit of research and prevention programs.

Discussed in detail by scientists from various disciplines are known and suspected genetic and environmental factors contributing to the development of cancer, the problems and limitations in current screening programs and proposals for the orientation of future research and preventative measures.

Although some of the articles presented and much of the discussion following these articles are technical, certain sections, such as those dealing with environmental factors and public education, may be read with little difficulty by the non-scientist.

Gersuny, Carl. Work Hazards and Industrial Conflict. Hanover, NH: University Press of New England, 1981.

Although legislative reform since 1910 has substantially mitigated the conditions of the worker, industrial conflict continues as new hazards replace old. According to the author, this conflict, rooted in the underlying inequalities in risk of injury and occupational illness between the worker and those in power who decide what and how much risk is acceptable, is an unavoidable consequence of the dilemma between safety and productivity. Through a review and comparison of historical and contemporary case materials, it is shown that while legislation has changed the ground rules for conflict, channelling it into the political arena, class structure remains at the heart of current legal and political controversies over health standards. This book offers the reader valuable insight into the social, political, and economic factors confronting the worker and the community in the battle against occupational health standards.

Glucksberg, Harold and Jack W. Singer. Cancer Care: A Personal Guide. Baltimore, MD: Johns Hopkins University Press, 1980.

This book was written primarily to dispel myths and misconceptions about cancer cures and the opposite - certain death. It offers a brief and generalized discussion about cancer and carcinogens in the environment and provides information on the various types of cancer and their current treatment.

Greenwald, Howard P. Social Problems in Cancer Control. Cambridge, MA: Ballinger Publishing Co., 1980.

The author states that the problems attending the control of cancer are more properly defined as social problems rather than problems of economics, budget constraints or regulation. In outlining the problems of cancer control, he attempts to demonstrate the importance of interpersonal and organizational factors even in the presence of definitive legislative action and abundant material resources. Written for health care planners and analysts, this perspective has utility for the reader interested in the problems associated with the control of cancer, including those cancers linked to occupational hazards.

Grey, Jerry. Low Level Radiation. Atomic Industry Forum, 1974.

This short booklet introduces the reader to the subject of radiation, its uses and its effects on health. It also contains brief and simple explanations of models such as the linear and threshold theories, used to determine and set standards for levels of human exposure.

Handbook of Occupational Safety and Health. Chicago: National Safety Council, 1976.

Written as a guidebook for owners, managers and safety representatives, this book is intended as an introduction to occupational health and safety for persons with little health and safety experience. The major portion of the first half of the book contains advice and guidelines on how to set up an effective safety and health program and how to set priorities. Later sections contain information on worker attitudes and behavior, how to educate and communicate safety measures to employees and how to motivate employees to adopt safe health practices on the job.

The value of this book to the individual interested in the subject of occupational cancer is that it provides some insight into what is being communicated to employers, management personnel and workers about health regulations and practices.

Harlem, O.K. Communication in Medicine: A Challenge to the Professions. New York: S. Karger, 1977.

This book describes the process of communication and interpersonal communication in non-technical terms and then applies it to the specific area of transmission between doctor and patient and the general public. The author also examines the effective use in medicine of television and satellites as a means of educating the public. Intended primarily for medical students and personnel, this book should also appeal to those concerned with effective communication of medical facts but with little background in communication or the behavioral sciences.

Havelock, R.G. Planning for Innovation Through Dissemination and the Utilization of Knowledge. Ann Arbor, MI: University of Michigan Institute for Social Research, 1969.

Dissemination and utilization of knowledge are viewed as a transfer of messages by various media (linkages) between the resource, or sender of the message, and the user, or receiver of the message. In reviewing the processes of innovation, dissemination and utilization, this study concludes that senders and receivers can achieve successful linkage only if they exchange messages in a two-way interactive process and continually attempt to stimulate each other's problem-solving behavior. As such, effective communication depends upon the psychological disposition and attitudes of the resource and user, as well as sociological influences and needs. Successful linkage is not only effective, but builds a relationship of trust which aids in fast, efficient and effective information transfer. The implications of this study are that effective knowledge utilization requires a degree of labor division, coordination and collaboration throughout the social system and that the role of government should be to develop means to support and facilitate the knowledge flow system. The study concludes with recommendations for additional research and offers guidelines for practitioners and policymakers concerned with the use and flow of information to the public. This report provides a framework for understanding the dissemination and utilization of information and reviews the relevant literature in education and other fields. An extensive bibliography is included.

Hiatt, H.H. and J.D. Watson and J.A. Winsten (eds.). *Origins of Human Cancer*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory, 1977.

This three volume set of books provides a comprehensive summary of the major issues in cancer research presented at the Cold Spring Harbor Conference on cellular proliferation in 1977. The papers cover a wide range of topics from cancer epidemiology to cellular changes to a thorough discussion of animal tests and short term bioassays. The material presented runs the gamut from highly scientific technical articles to easily understandable general policy. This is an excellent resource for both teachers and students.

Huseman, Richard C., Cal M. Logue and Dwight L. Freshley. *Readings in Interpersonal and Organizational Communication*, 2nd Edition. Boston, MA: Holbrook Press, Inc., 1973.

This collection of articles originally written for publication in various professional journals deals broadly with the subject of communication - its nature, inherent problems and the means to effective communication in the organizational and social frameworks. Two sections, one entitled "Communication and Conflict" which focuses on communication and conflict in various settings, and "Communication, Motivation and Persuasion" which deals with the important topic of how the individual can effectively influence society, are noteworthy.

Kessler, Irving I., editor. *Cancer Control: Contemporary Views on Screening Diagnosis and Therapy*. Baltimore, MD: University Park Press, 1980.

Cancer control here is broadly defined and includes "any preventative diagnostic or therapeutic modality that may decrease morbidity or mortality attributable to cancer." A volume containing contributions by several authors, it begins with a discourse on the breadth of the cancer problem worldwide and an overall assessment of the current status of the many approaches to cancer control and the prospects for the effective control of cancer in the future. A review of the approaches to decision-making in cancer screening and suggestions for the selection of suitable cancer screening methods are also addressed.

Lusterman, Seymour. Industry's Roles in Health Care. New York: The Conference Board, Inc., 1974.

Based on a survey of over 800 large (greater than 500 employees) companies and interviews with executives, personnel directors and health professionals and planners, this report examines current health care programs provided by the employer, describing the advantages and disadvantages of the major health care options. In addition to statistical data on the type and quality of health care offered, the study also addresses such questions as the responsibility of the employer in providing occupational and non-occupational health care and the role of business in effectively ameliorating the problem of health care delivery in the United States. Opposing views on the various questions and issues are presented and future strategies for the improvement of health care policy are discussed.

Magee, Peter N., et. al., Editor. Fundamentals in Cancer Prevention. Baltimore: University Park Press, 1975.

The monograph of a symposium, this volume approaches cancer prevention from a wholly scientific perspective. It covers the range of scientific progress and problems in epidemiology, toxicology, screening, prevention and control. Suitable for those with a background in the physical sciences, with the exception of a chapter, "Thoughts on the Prevention of Cancer," the lay person may find much of the material presented a bit too abstruse.

Magid, King. Industrial Hazard and Safety Handbook. Boston: Neones - Butterworth, 1979.

This lengthy volume is unique in several aspects. Unlike other books of its type, it identifies and warns of the main hazards found in industry and deals with common hazards rarely discussed, including those caused by or hidden in secrecy about industrial processes. Further, it demonstrates with great clarity how knowledge, training and understanding can prevent practices which lead to ill-health and can promote cooperation between management and workers. Written to appeal to a wide audience, this book serves as a good reference for either general or specific studies dealing with occupational health and contains extensive bibliographic materials.

Mendeloff, John. Regulating Safety: An Economic and Political Analysis of Occupational Safety and Health Policy. Cambridge, MA: MIT Press, 1979.

In the conflict over how much and what type of regulation of occupational health hazards is appropriate and necessary, critics of regulation (economists and business people) claim that the public must be educated as to how much it is costing the consumer to regulate social "evils." Supporters of regulation, on the other hand, argue that the benefits to society are underestimated. By considering the economic and political perspectives and social values, this study examines why we have the occupational health and safety policy we have, assesses how well it is working and proposes improvements. In the attempt to understand the way in which economic issues are considered in regulatory policy making, the author produces a highly polemic critique of OSHA and its social effectiveness.

A select bibliography and reference materials are provided.

Mettlin, Curtis and Gerald P. Murphy (eds.). Cancer Among Black Populations. New York: Alan R. Liss, Inc., 1981.

This is a collection of scholarly yet readable papers reporting on research in Africa, the Carribean and the U.S. The articles attempt to define the scope of cancer incidence and survival rates, speculate upon causes and propose preventive strategies. In doing so it is practically impossible to omit the social factors which present barriers to both understanding and affecting cancer among Blacks all over the world: the insensitivity of medical recording and census data, the quality of medical services, the likelihood of having a dangerous job and poor overall health status, etc. These are presented in a straightforward manner which will be appreciated by anyone frustrated by the simplicity of most statistics regarding cancer rates among Blacks.

Moss, Ralph W. The Cancer Syndrome. New York: Grove Press, 1980.

The Cancer Syndrome is an attack on "the cancer establishment," Moss's term for the group of individuals, medical centers, organizations and government agencies at the center of most efforts involving cancer in this country. Due more to similar interests than to conscious design, the members of the cancer establishment work together to insure that research and treatment of cancer proceed in a direction which benefits themselves rather than dealing with the problem effectively. In a well-written and meticulously documented work, Moss investigates the "proven methods" of cancer therapy, "unproven methods" and prevention.

Proctor, Nick H. and James P. Hughes. Chemical Hazards of the Workplace. Philadelphia: Lippincott, 1978.

The philosphy underlying this work is that in order for OSHA to be at all responsive and effective, the quality of occupational health care requires attention. Thus, the book was written to provide occupational health physicians and specialists up-to-date reference and educational material. Assembled is basic information regarding the chemical, physical and toxicological characteristics of carcinogens and mutagens found in the workplace, criteria for diagnosing, testing and treating occupational diseases and guidelines for preventing, monitoring and controlling exposure. This monograph is comprehensive, not too technical in language and descriptions and need not be read in its entirety.

Public Opinion on Environmental Issues; Results of a National Public Opinion Survey. CEQ/USDA/DOD/EPA. 1980.

This report summarizes the results of a number of environment-related public opinion polls as well as reports on a survey conducted by Resources for the Future, the Council for Environmental Quality. A number of topics are addressed, including spending for environmental protection, protecting the environment vs. economic growth, the environment vs. energy, trends in concern about the environment, knowledge, and views on regulation. A survey of the respondent's answers reveals that the public is concerned about the environment and overwhelming in support of environmental protection measures. This report provides a good starting point for various additional analyses.

Purdon, P. Walton and Karl L. Gabriel. Environmental Health, 1st Edition. New York: Academic Press, 1971.

A comprehensive overview of the "man-environment-health" interaction, this text is concerned with the interaction of man and his environment as it affects his mental and physical health and social well-being. Environmental conditions that foster the transmission of disease and exposure to chemicals and hazardous physical conditions are reviewed. Although not confined to the subject of occupational cancer, this text provides a broad range of perspectives for anyone with a general interest in environment-health interactions and serves as a substantial base for those who desire to further pursue specialized areas. The authors do, however, assume a familiarity with the basic sciences.

Three chapters are of particular interest to those concerned with occupational cancer. These are: the introduction, "Environment and Health," by Purdom; "The Occupational Environment," by Gabriel; and "Ionizing Radiation," by Jack C. Rogers.

Radiation Protection: A Systematic Approach to Safety; Vols. 1 and 2. New York: Pergamon Press, 1981.

A collection of papers presented at an international symposium, this book focuses on the wide range of issues associated with both occupational and patient exposure to radiation. In addition to containing the purely scientific and research oriented aspects of the monitoring and release of radioactive emmissions, risk measurement and quantification and the biological effects of exposure, other topics include: the ethical and legal problems associated with exposure and risk assessment; emergency planning in the event of accidental or intentional release; and a description of non-ionizing radiation. Although many readers may find some of the material to be too technical to be of benefit and may wish to skip over these sections, the book offers a valuable overview in this area and is worthwhile reading for anyone interested in occupational cancer resulting from exposure to radiation.

Shaw, Charles R., Editor. Prevention of Occupational Cancer. Boca Raton, FL: CRC Press, 1981.

The several contributors to this volume explore the questions of "what is cancer" and "how much is caused by occupational exposure?" Intended to appeal to the level of the educated layman, their major purpose is to give the reader enough reference and detail to enable him or her to pursue further any one of a number of specific issues or problems. Individual chapters deal variously with such topics as the action, metabolism and epidemiology of known and suspected carcinogens, the identification of carcinogens through animal and short-term testing, the laws and regulations governing occupational carcinogenesis, prevention, workplace safety and the roles and responsibilities of society, the employer and the worker in the effort to abate occupational cancer. Not included in this overview is a section on ionizing radiation but most of the preventative principles discussed can be applied to it as well.

Showalter, David. How to Make the OSHA - 1970 Work for You. Ann Arbor, MI: Ann Arbor Science Publishers, Inc., 1972.

Another source book written for managers and employees, it approaches health and safety practices from the perspective that OSHA can work to effectively reduce occupation-induced illness and disability and that it can be profitable for the employer. The scope and intent of OSHA - 1970 are interpreted in simple, straightforward language and the salient points of the regulation are outlined.

Smith, Robert S. *The Occupational Safety and Health Act: Its Goals and Its Achievements*. Washington, D.C.: American Enterprise Institute for Public Policy Research, 1976.

The view put forth in this short book is that the basic problem with the implementation of the Occupational Health and Safety Act of 1970 is that there is no fundamental agreement either on the Act's goals or on the methods of balancing considerations of safety and health against considerations of cost. By examining the essential features of OSHA, its administration and its impact, the author argues that the health and safety mandate of OSHA is inconsistent with the promotion of general welfare and proposes the "more defensible alternative" of allowing the workers to decide how much safety they want. Technical and statistical data are offered as evidence in support of the claims and proposals made in this study.

Sontag, James M., Editor. *Carcinogens in Industry and the Environment*. New York: Marcel Dekker, Inc., 1981.

This is a thorough and comprehensive treatment of the scope and complexity of the problems arising from the use of cancer-causing agents in industry and in the environment. It introduces the reader to the scientific, legal, social and economic considerations in the testing, monitoring, and setting of standards and regulations for carcinogenic compounds. One major difference between this and other books of its type, which the reader may find both interesting and useful, is the discrimination made here between compounds labelled "serious hazards" and those considered to involve "marginal risk."

Sontag, Susan. *Illness as Metaphor*. New York: Farrar, Straus and Giroux, 1978.

An entirely different perspective on those factors which influence the prevention and treatment of cancer written by one who has had to deal with the reality of cancer, *Illness As Metaphor* raises objections to the fantasies and metaphorical thinking that surround the subject of cancer.

Using examples taken from literature, from current psychological reports on the nature and causes of cancer and from news articles, the author attempts to show both how widespread the cancer metaphor is and how dangerously it distorts the truth about cancer and cancer patients. The view taken is that the use of cancer as a metaphor is rooted in the insufficiencies and real problems of our culture and the hope expressed is that once cancer is demystified - once the causes are known and the recovery rate high - it will also be "demythicized."

Upton, Arthur. Radiation Injury: Effects, Principles and Perspectives. Chicago: University of Chicago Press, 1969.

This small volume is targeted on the biomedical aspects of exposure to radioactive particles. It includes an extensive bibliography on recent research studies in this area.

Whelan, Elizabeth. Preventing Cancer. New York: W.H. Norton and Co. Inc., 1978.

According to this author, the effective control of cancer is not a curative process but a preventative one and is dependent upon both environmental changes and individual action. This book is directed toward the latter, that is individual action, with the purpose of prescribing what the individual can do to avoid cancer. The discussion of occupationally related cancer is very brief and the reader may find the author's exoneration of certain environmental "hazards" somewhat objectionable.

Winick, Myron. Nutrition and Cancer. New York: John Wiley and Sons, 1977.

A more technical handling of the topic, this book examines the relationship between nutrition and cancer in three aspects: in the etiology of cancer; in cancer as it affects the nutritional status of the patient; and nutrition as a method of treating certain cancers. In each of these areas the research to date is described and suggestions are made for future research.

Winters, Ruth. Cancer-Causing Agents: A Preventative Guide. New York: Crown Publishers, 1979.

A worthwhile reference for the layperson, this book contains information on known and suspected carcinogens. Definitions of the chemical terms used and of the types of cancer induced are provided along with additional references for each chemical listed. A brief overview of epidemiologic studies, pertinent statistical information and the theories and mechanisms associated with cancer induction are given in the introductory chapters.

Wolf, Steward, John G. Bruhn and Helen Goodell. Occupational Health as Human Ecology. Springfield, IL: Charles C. Thomas Publications, 1978.

Stating that "...occupational health cannot be thought of merely as a medical specialty - it is everybody's business...," the author examines the role of the worker, industry, the unions and the medical professional in generating and maintaining a responsive and effective occupational health program. Central to the development of such a program is the recognition that current health hazards differ significantly from those of the past. To support these points, the author traces the evolution of occupational medicine, discusses current practices and legislation in terms of the major threats to health, including worker attitudes and behavior, and outlines an occupational health program based on an expanded view of occupational health.

The book is brief and easily readable with references provided after each chapter.

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